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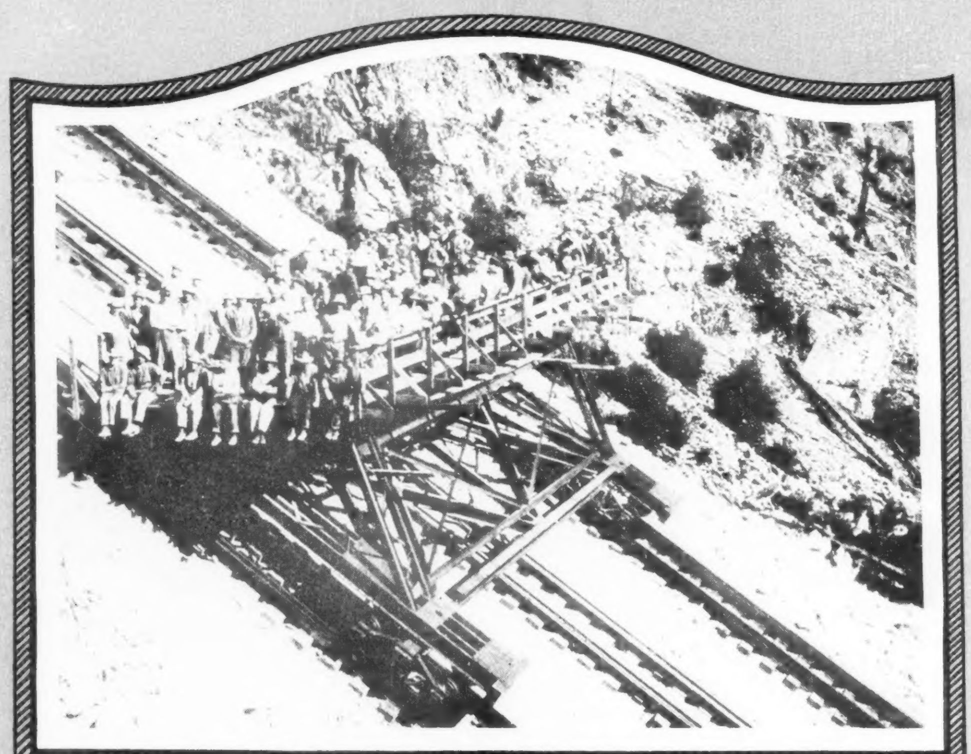

FUNICULAR RAILWAY ON SIXTY-EIGHT PER CENT GRADE THAT LINKS RAILROAD IN VALLEY WITH HIGH-LEVEL TRACKS AT DIABLO DAM

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As It Seems To Us

A MELODY WITH A PAST

WE have by decree of Congress a national anthem. For 150-odd years bands played and people sang various airs in the fullness of a patriotic spirit believing their choice in each case to be the country's anthem. Now, by reason of the Act of March 4, 1931, *The Star Spangled Banner* will henceforth be the national anthem; and some of us wonder whether our legislators seriously pondered their choice or gave it casual approval in the hurried hours of the session's closing.

Most of us are familiar with the circumstances surrounding FRANCIS SCOTT KEY'S conception of his patriotic verses. We know they were inspired by his pent-up feelings as he watched the bombardment of Fort McHenry while virtually a prisoner aboard one of the attacking British men-of-war. Great, indeed, was his joy at dawn to see the Stars and Stripes still floating gallantly above the beleaguered stronghold. The attack had failed, and Baltimore was secure!

A brief account, believed to be the first one touching upon the origin of *The Star Spangled Banner*, was printed in the *Baltimore American* on September 21, 1814, just following the defeat of the British forces. The text of KEY'S poem as then printed was without special title, but the article closed with this significant sentence: "Tune: *Anacreon in Heaven*". The choice of that melody was made, so it is said, by one FERD DURANG, a soldier belonging to the Pennsylvania Volunteer Militia which had gone from Harrisburg to serve in the defense of Baltimore. DURANG, after hunting for a tune to fit the lines, found one in a volume of old flute music. Turning to his comrades, DURANG exclaimed: "Boys, I've hit it!", and, fitting the tune to the words, they sang out for the first time the song of *The Star Spangled Banner*.

Another version of the vocalizing of the poem states: "It was first sung by about twenty volunteer soldiers, in front of the Holliday Street Theater (Baltimore), who used to congregate at the adjoining tavern to get their early mint juleps." The old English drinking song entitled *Anacreon in Heaven* contains the following response of Anacreon to "a few sons of harmony" who had petitioned him for his inspiration:

"I'll lend ye my name, and inspire ye to
boot;
And, besides, I'll instruct ye, like me, to
intwine
The myrtle of Venus with Bacchus's vine."

KEY'S poem will remain immortal by reason of the patriotic sentiment with which its verses are replete; but where one person will be familiar with the words a hundred will know only the associate tune; and a little research will disclose the very, very wet—even bibulous—traditions of the melody.

PULLMAN'S CENTENARY

GEORGE MORTIMER PULLMAN came into the world one hundred years ago; and before his demise in 1897 he had seen the ripe fulfillment of his youthful desire to devise and to build sleeping cars that would make railway travel at night bearable if not always pleasurable.

PULLMAN'S fame rests not only upon his development of the sleeping car but upon his success in adapting cars to changing track gages and thus emphasizing the advantages inherent in equipping either cars or tracks so that the vehicles could be hauled long distances over connecting rails. It is a matter of history how PULLMAN in 1858 and 1859 remodeled two old day coaches so that they could be used as sleepers. One of these, the historic *No. 9*, although woefully crude, was nevertheless fundamentally sound in principle. ABRAHAM LINCOLN and many other notables rode in it.

From the days of the *No. 9* to the end of his life, PULLMAN worked tirelessly for the improvement of cars, service, and methods. Safety was ever foremost in his mind; and this led eventually to all-steel construction and other safety features. Before Pullmans were introduced cars had four or eight wheels: GEORGE PULLMAN gave his twelve wheels. He found cars without springs, and he provided his with springs of the best. He abolished flickering candles and substituted, first, oil lamps, later, gas, and finally, after prolonged experiments, electric lights. Finding cars with flat roofs and no ventilation, he gave his a raised upper deck and efficient ventilation. He scrapped dangerous car stoves, and progressively provided safer and better methods of heating.

The sleeping car was followed by the parlor car; and the cars grew longer, higher, and more spacious while arrangements, fittings, furnishings, and kindred features were improved in design and style. As long-distance travel developed, a demand for diners was created; and these, too, PULLMAN produced. In short, step by step, he evolved both parlor and sleeping cars as we know them today. It is interesting to recall that chance turned the tide in PULLMAN'S favor when the odds were desperately against the acceptance of the first of his cars. The part played by his *Pioneer* in Lincoln's funeral train blazed the way to recognition.

It is a matter of general knowledge how GEORGE M. PULLMAN brought into being a great industrial center south of Chicago, Ill., and how that community, known as Pullman, flourished with a distinctive character as long as its creator lived. In the vast plant that was reared there all kinds of railway cars have been constructed; and in the course of 50 years the shops have turned out 41,000 passenger cars and 312,000 freight cars.

The traveling public the world over is indebted to the genius and the persistence of PULLMAN; and it is befitting that the centennial of his birth be commemorated.

CUBA'S CENTRAL HIGHWAY

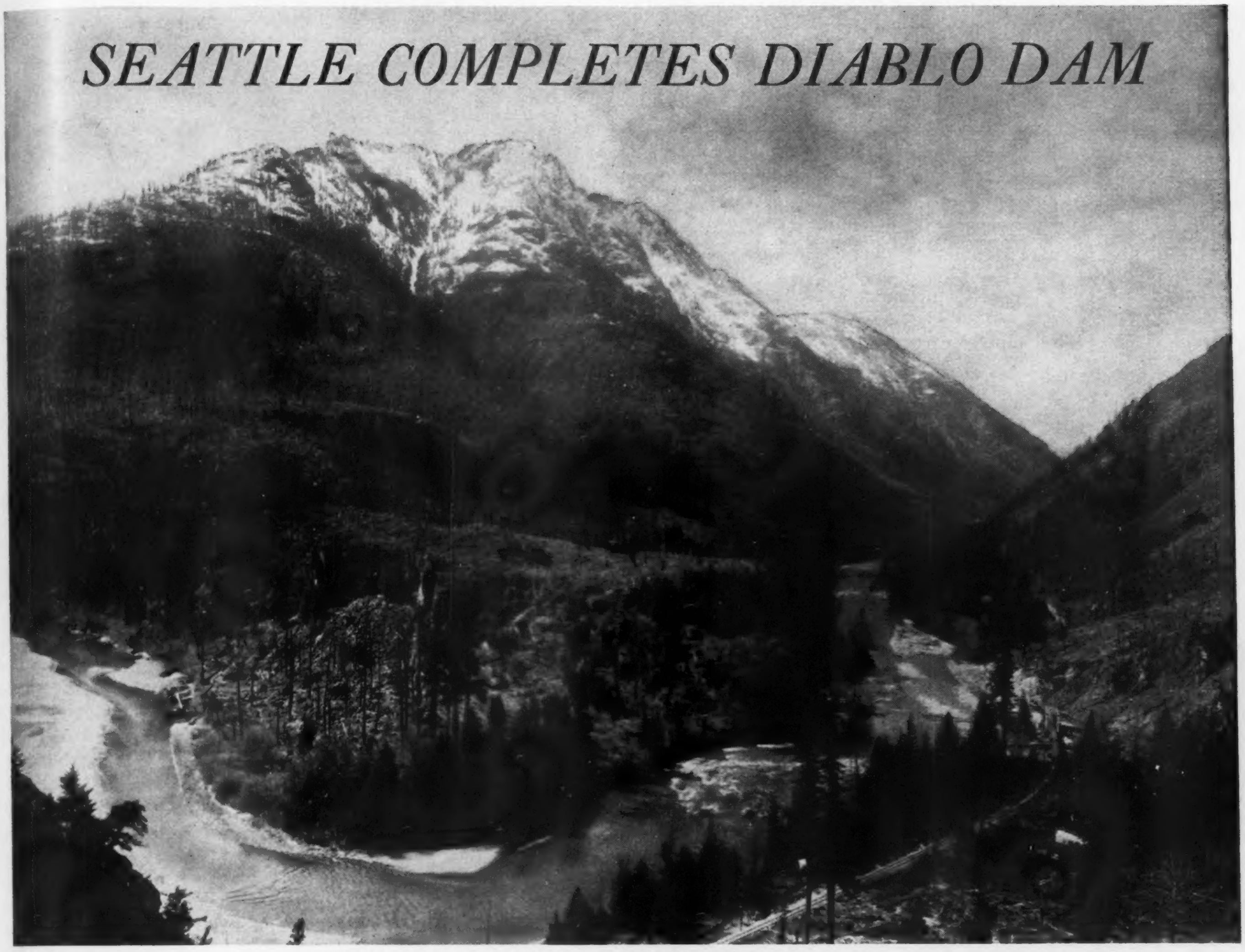
CUBA points with pardonable pride to the completion of her great Central Highway that measures from end to end 705.6 miles. It is a typically modern motor road, paved for its full length and having a general width of nearly 21 feet flanked by shoulders that are a trifle more than 5.5 feet wide.

This splendid thoroughfare traverses the center of the island; and authority for its construction was given by the law passed by the Cuban Congress on July 15, 1925. The necessity for the highway arose from conditions under which existing roads in many parts of the island were maintained. Those roads were difficult to traverse in numerous places for all but the most primitive types of vehicles. The new road bisects the island from Pinar del Rio, in the west, to Santiago de Cuba, in the east, touching the coast at Havana and Matanzas on the north. Ultimately this fine transportation artery will give access to the interior of all the provinces and be the means of promoting the prosperity and the development of the entire island. All told, this enterprise, with certain associate work, will entail an outlay close to $100,000,000.

Small though Cuba is compared with other American countries, still she stands forth conspicuously among the nations of the western hemisphere that have gone in extensively for thoroughly modern highways. Indeed, Cuba, with her relatively limited resources, has accomplished more than any other country in the world in building a 700-mile thoroughfare of such excellence. Heavy as the expenditures have been, still Cuba will reap a rich return; and it requires no stretch of the imagination to visualize the many thousands of people that will be drawn from abroad to travel that extremely picturesque route. The officials responsible for carrying the project forward despite criticism and opposition are to be commended for their courage; and it is gratifying to the United States that she furnished so many of the contractors and so much of the essential machinery and materials required for the work.

Pyramid Mountain and Colonial Peaks, part of the watershed of the Skagit River.

SEATTLE COMPLETES DIABLO DAM



Skagit River a short distance below dam site in Diablo Canyon.

This Enterprising City Makes Big Stride in Harnessing the More Than Million Horsepower of the Skagit River

By R. G. SKERRETT

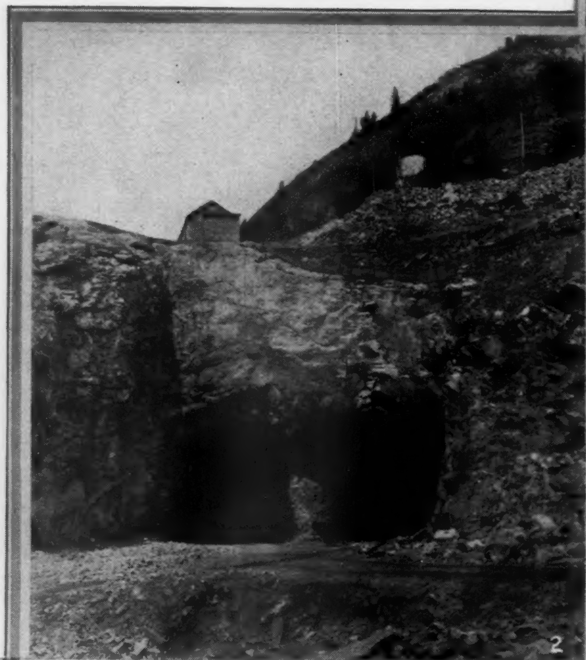
SEATTLE is steadily advancing towards completion the development of the hydro-electric possibilities of the upper third of the Skagit River. In so doing, she is making herself an increased source of interest to all students of municipal enterprises and economics. The Skagit has been described as a river of "a million horsepower"; and it is the purpose of the city to harness every bit of this energy so that she may become self-sufficient in providing power and light for both public and private services.

To properly evaluate what Seattle is doing in this direction one should recall that the city was little more than a modest fishing and lumbering village in the "seventies" of the past century. Probably the most optimistic of the town's citizens then never dreamed of the estate to which she would grow. Today the people immediately within her gates number no fewer than 365,000; and the population of the entire metropolitan district, as ascertained by the last census, is quite 468,000. This growth is convincing evidence of the natural advantages enjoyed by Seattle—set as the city is at a strategic point on our northwest coast; and her present importance is proof of how her capable citizens have made the most of their opportunities.

Seattle has been described as the largest city of her age in the world. She stands at the gateway to both Alaska and the Orient; and through the enterprise of her people she has become one of the outstanding manufacturing and industrial centers of the Pacific Coast. In these circumstances, it is easy to understand how the city fathers quickly grasped the advantages to be reaped by a widespread employment of electricity; and by way of a start Seattle called into being in 1904 what is said to be the first municipal hydro-electric plant in the United States. The records of the Department of Lighting of Seattle, over a period of 25 years, show that the demand for current has doubled on an average every five years; and this increase is now at a faster rate than heretofore. This situation accounts for a 5-year program that calls for the completion of the Diablo unit of the Skagit River Development in 1932.

The Skagit River is reputed to be one of the world's largest short rivers. It has a total length of 125 miles and draws much of its water from the western slopes of the Cascade Mountains. The upper third of the stream, now under development, has a watershed area of 1,200 square miles. Because of the nature of this watershed, and by reason of the many tributaries discharging into the Skagit, the river is subject to sudden floods. Precipitation averages 74 inches per annum; and the stream flow, recorded over a period of seventeen years, ranges from a minimum of 470 cubic feet per second to 100,000 cubic feet per second. The Skagit has been known to rise 22 feet in the course of ten hours!

Inasmuch as the section of the Skagit River being developed by the City of Seattle lies within Mount Baker National Forest, authority to proceed in this undertaking had to be obtained from the Government; and notice of this permission was received on December 25, 1918. Immediately thereafter, the city started her preparations on a carefully planned project which, when carried out to its finality, will make possible the



1—Cofferdam submerged by sudden freshet caused by melting snow that produced a flow of 27,000 second-feet. 2—Intake tunnels, 2,000 feet long, leading from above Diablo Dam to the power house below. 3—Diversion dam at left showing water disappearing into the tunnel beyond.

generating of 1,120,000 hp. from the descending waters of the harnessed stream. When finished, the Skagit River Development will consist of three dams and three associate power houses. The lowermost of these units—known officially as the Gorge Development—was put in service in 1924. That phase of the project was dealt with in some detail in the August, 1924, issue of Compressed Air Magazine, and we shall, therefore, not touch upon it now other than to say that a third generator was added to the plant in 1927—bringing the total output up to 75,000 hp. with the head available with the temporary dam now in service.

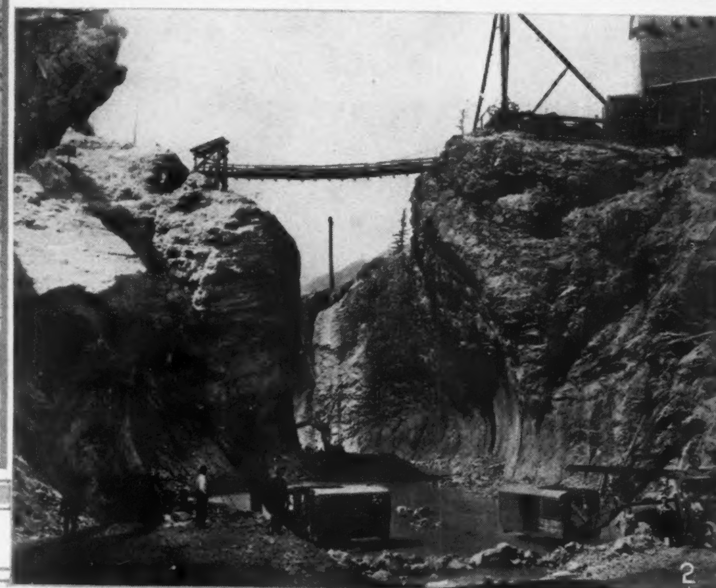
The Diablo Development, the one at present in hand, is situated 7½ miles above the Gorge Power House. The site was made accessible by extending the 23-mile spur line built preliminary to operations at the Gorge. The Diablo Development may be divided into two parts: a great dam, completed and dedicated last August, and a power house in which will be installed during the current year two generating units each of 95,000 hp. The construction of the power house includes the driving of a pressure tunnel 2,000 feet long and 19½ feet inside diameter. This tunnel will carry the water from an intake at the dam to a surge tank from which two steel penstocks will convey it to the wheels in the power house. The power house is under construction on Reflector Bar, down river from the dam.

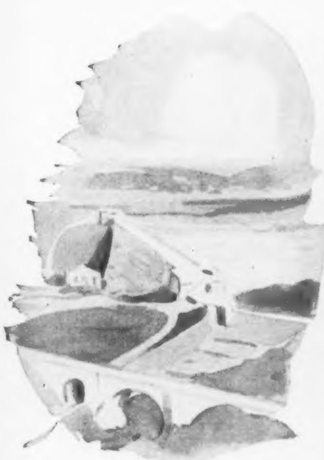
Inasmuch as the power house is building and the dam is completed, we shall confine the present article to a description of the dam and the work done in rearing it. It called for the united efforts of from 500 to 600 men over a period of 30-odd months. The Diablo Dam is, in effect, a stupendous wedge of concrete set firmly in place and locked to the flanking rocky walls of Diablo Canyon. These walls bear testimony to the erosive action of the river during the thousands of years in which its waters have been wearing a passage through the obstructing granite; and just how the canyon crowds the river in its course is emphasized at one point by a gap of only 19 feet between the confining walls.

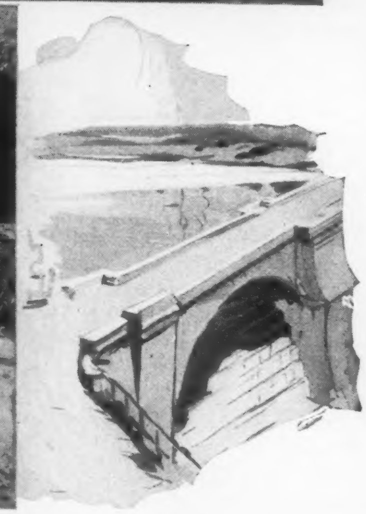
Even though the site chosen for the dam had much to commend it, still it bristled with difficulties that had to be mastered. As one of the engineers on the job has recently expressed it: "Three years ago we stood on the suspension bridge considering the job to be done. As we looked down the precipitous walls of Diablo Canyon, the river's roaring seemed to be the sarcastic guffaws of some Gargantuan force. For the Skagit can and does multiply itself over night from a puny little stream of a few hundred cubic feet to an irresistible flood of many, many thousand cubic feet per second. Frankly, I don't know whether we are prouder of the dam, itself, or of the victory won in battling the river to a standstill in order to build the dam".

Having obtained from the Federal Power Commission in February of 1927 a permit to build the Diablo Dam and power plant, the municipal authorities of Seattle lost no time in making the needful preparations for carrying out that great undertaking; and on September 30, following, a contract for the construction of the dam was awarded Winston Brothers Company, of Minneapolis, Minn. That capable and enterprising concern got busy with all practicable dispatch. Well-nigh the first thing that had to be done was to create a comfortable and healthful construction camp that should be sufficiently permanent in its arrangements to take care of the working force over a period of close to three years. Bunkhouses were constructed for the single men and separate homes for the married members of the organization. Every reasonable convenience, sanitary and otherwise, was provided; and up-to-date methods were employed in the preparation of food for the majority of the men on the job. Working as they did for the most part out of doors, the men were a hungry lot when mealtime arrived; and every effort was made to satisfy them with an abundance of varied and appetizing food. During the course of the work the camp kitchen prepared as many as 1,000,000 toothsome meals.

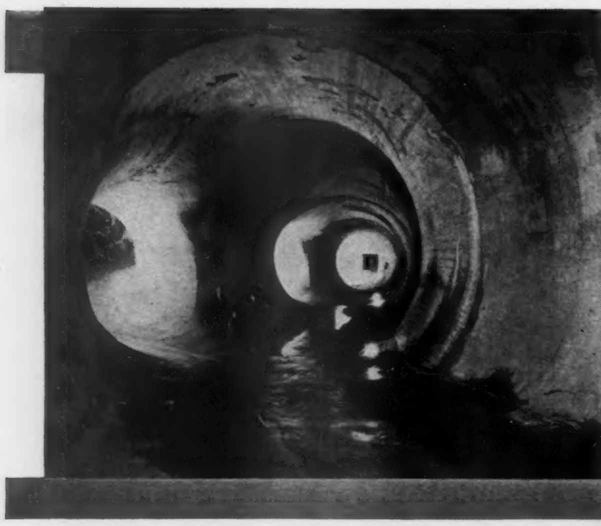
Stated briefly, the task of the contractor consisted of rearing a dam 389 feet high, 1,180 feet long on the crest, 140 feet wide through its base, and 16 feet wide at the crest. The dam was to contain 350,000 cubic yards of concrete, and was to be securely anchored to the walls of the canyon and to the solid rock underlying the bed of the Skagit. Imposing as the foregoing figures are they give







1—Looking downstream from the diversion dam with entrance to the tunnel at extreme left. 2—Power shovels excavating for the Diablo Dam in the unwatered river bed. 3—Diversion dam in course of construction. 4—Diablo Dam site viewed from downstream. 5—Work on the diversion dam and tunnel during a period of low water.




Left—Lower end of tunnel at Gorge plant showing branches leading to the three power units. Right—Diversion tunnel at Diablo Dam near the upstream portal.

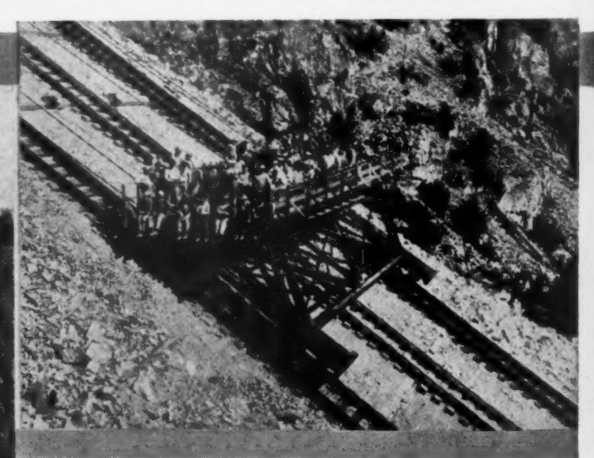
but an inadequate conception of the magnitude of the problem with which the contractor had to contend. The dam has created a lake six miles long capable of storing 90,000 acre-feet of water; and it was essential that this exceptionally high dam should be strong enough in every particular to withstand any stresses that might be set up by the impounded water. To this end, it was decided by the city to rear a constant-angle arch-type dam designed by the well-known dam expert, Lars Jorgenson.

The dam as viewed today from the downstream side has so changed the appearance of the canyon as to mislead a casual observer concerning the difficulties that were contended with in the bottom of the gorge before the structure began to rise from the depth of the river bed. The dam is set in a gorge cut through solid granite; and that gorge at the base of the dam was only 125 feet wide. Just below the dam site the river runs between the sheer walls of Diablo Canyon—the walls mounting to a height of 200 feet above the normal surface of the Skagit. Picture the conditions existing when the river was swollen at flood periods and surging angrily through that constricted passage.

Before any work could be done on the dam it was necessary to provide a new channel for the river so that its age-old bed could be unwatered. This was accomplished by driving, on the south side of the river, a diversion tunnel 20 feet in diameter and 650 feet in length—the tunnel piercing solid rock. The intake of the tunnel is 250 feet upstream from the dam; and the outlet is somewhat farther below the dam. The tunnel was driven from four headings: one at each portal and two, working in opposite directions, from a 9x9-foot adit driven in to the line of the diversion tunnel from a point 125 feet downstream from the intake end.

The river was directed into the tunnel by a diversion dam 250 feet long. This cribwork dam was constructed of big fir logs, many of which were from 3 to 4 feet in diameter and 40 feet in length. The cribwork was weighted with rock and thus sunk to the gravel bed of the stream. The logs were held together with double drift bolts, and the top courses of the cribbing were lashed in place with wire rope. The upstream face of this dam was reinforced with 18,000 linear feet of 14-inch steel sheet piling driven into the river bed.

As a further aid in unwatering the river bed above and below the dam site, but between the diversion dam and the discharge end of the diversion tunnel, cut-offs were formed in the stream bed. The upstream cut-off was just above the base of the main dam, while the downstream cut-off was situated about 100 feet below the downstream toe of the dam and at a point in the river bed where the gorge was approximately 60 feet in width. The presence of large boulders in the stream bed made it next to impossible to shut out effectually with sheet piles all water working through the formation. Therefore, holes 6 inches in diameter and spaced 9 feet apart were drilled right down through the deposited boulders. These holes, carried down to bedrock, were staggered and extended in two rows from side to side of the gorge. Grout was forced into them under considerable pressure; and in this way the boulder formation was consolidated and a

Left—Incline railroad that played an important part in raising freight from the lower to the upper railway levels. It climbed 313 feet in a run of 563 feet. Right—Incline railway handling a shift of working men.

1—Dam completed with the exception of arches and 18-foot roadway. 2—Dam nearing completion and viewed from above southern spillway. 3—How the dam looked when nearly finished and viewed from a point above the north spillway. 4—The nearly completed dam seen from a hillside downstream.

1—Gravel bar in Skagit River three-quarters of a mile below Diablo Dam. 2—Gravel-washing plant on Reflector Bar. 3—Monighan 2½ yard drag line excavating sand and gravel.

well-nigh impervious wall formed at each cut-off. What leakage occurred was at the sides of the gorge where the grout failed to penetrate crevices between some flat boulders—the seepage being easily handled by the pumps set up between the cut-offs.

The next step consisted of stripping the side walls of the canyon to provide lateral anchorages for the dam. This work was taken in hand before the channel excavation was started for the central foundation of the dam. The stripping of the side walls was scarcely begun before the fatal collapse occurred of the St. Francis Dam in California. Instead of halting the stripping at the intended depth of about 12 feet, the excavating of the rock was continued and carried to depths of as much as 70 to 80 feet in certain places so as to insure a wide margin of safety for the dam. The river bed was excavated to a depth of 50 feet for the channel foundation; and the stripping of the side walls and the digging in the channel entailed the removal of 230,000 cubic yards of rock. Some of the boulders were so firmly wedged in the river bottom that the dippers of the power shovels had to be armed with teeth of a chrome-steel alloy—manganese-steel teeth lasted for only an 8-hour shift!

Sand and gravel for concrete were dug from the river bed at Reflector Bar; and, after washing, they were transported by an incline railway and a high-level track to bunkers on the north side of the project. Cement, in bulk, was delivered in carload lots and moved by a 24-inch belt conveyor to storage silos. A 30-inch belt conveyor carried sand and gravel from the bunkers to the concrete mixing plant. Both of the conveyors mentioned were about 700 feet long.

Concrete from the mixing plant was delivered by chutes to the hoppers of the steel towers, and from the hoppers the concrete was loaded by gravity into hoisting buckets and then raised to the belt-conveyor systems which placed the concrete where desired on the dam. The towers were so located and the conveyor system so designed that concrete could be placed directly over any part of the dam save the two end sections. The towers rose 80 feet above the crest of the dam. One of them was 324 feet high and the other reached to a height of 432 feet—the towers being set on different levels. As much as 1,500 cubic yards of concrete was placed in the course of a day.

A high-line cableway, almost 2,000 feet long, stretched from side to side of the gorge. This cableway was anchored directly to the solid rock of each flanking mountainside and was made up of 2¼-inch wire rope. It was capable of carrying safely a load of 15 tons; and the lowest point of sag in that line was 500 feet above the river. The cableway made it possible to handle outlet pipes 8 feet in diameter, weighing as much as 13 tons, and to lift and to lower into place gates and other large features of the dam equipment.

We have given but a bare statement of the general features and the outstanding problems incident to the construction of the Diablo

Dam, and much has been omitted which would serve to add glamor to this really magnificent achievement. As has been said, every problem was solved, every battle was won; and Diablo Dam stands and will stand for centuries to come—a majestic monument to civilization's ever-increasing control of the titanic but riotous forces of nature.

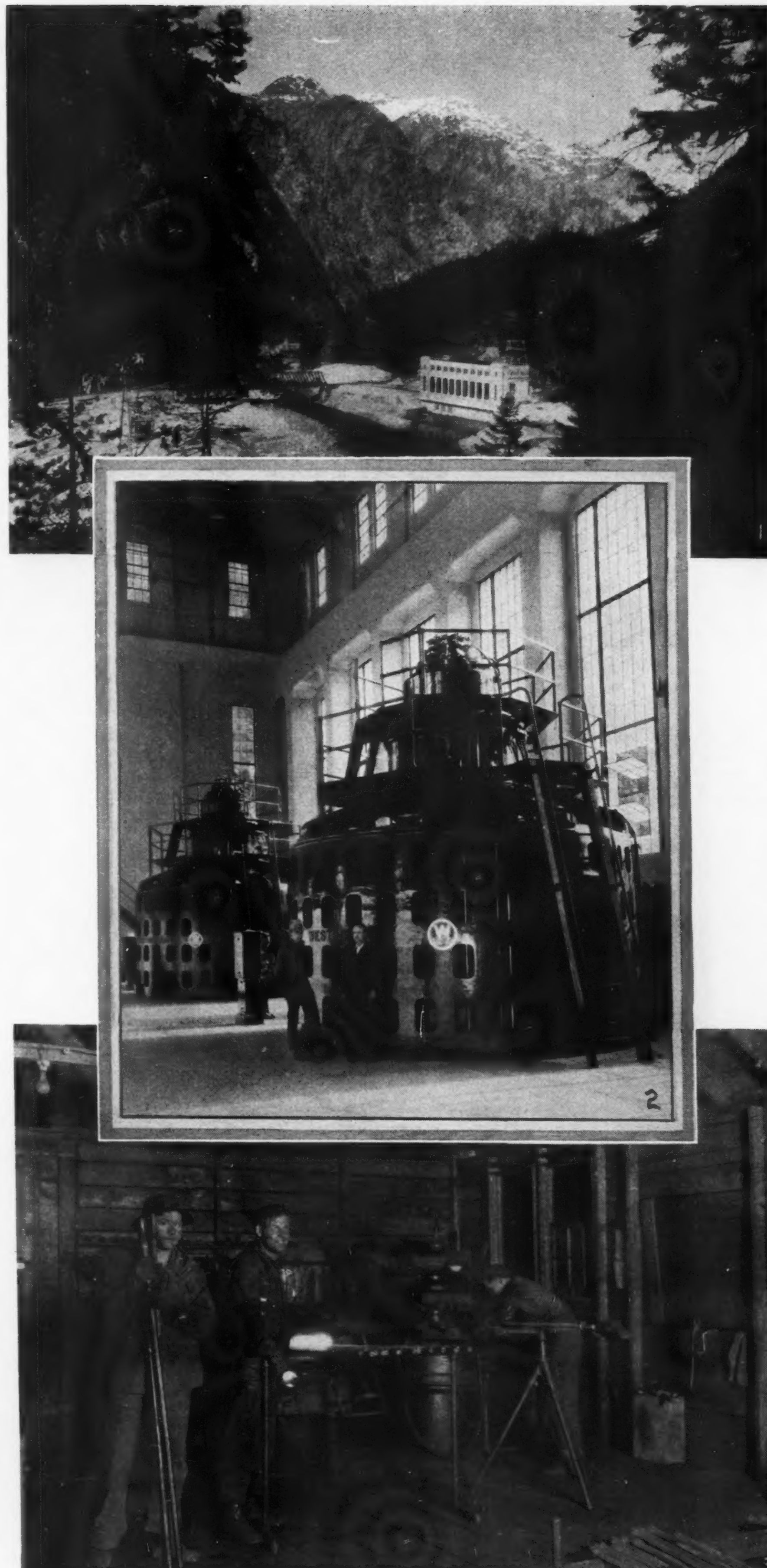
According to the program of the Department of Lighting of the City of Seattle, Diablo Dam, its associate power house, and the long transmission line to Seattle will be complete and ready for service some time in 1932. In the meantime the city is already directing its attention to the Ruby Development six miles farther upstream from the Diablo plant. The Ruby Development calls for the erection of a dam 610 feet high and 1,200 feet long on the crest. The reservoir so formed will be 30 miles long and from one to three miles wide. This lake will be capable of impounding 3,000,000 acre-feet of water and be sufficient to equalize the entire run-off of the river for power purposes. In the Ruby power house there will be placed six 60,000-kw. vertical generating units; and they will operate on an average head of 450 feet. Two pressure tunnels, 600 feet long and 30 feet in diameter, will be driven through granite to carry water to the penstocks leading to the generators. The ultimate development of the estimated 1,120,000 hp. that can be garnered from the Skagit will cost, with transmission lines, a total of $74,500,000. This will represent about $66.65 per horsepower of current delivered—a notably low figure.

Much has been accomplished since the City of Seattle began work on the Skagit River Development following the granting of permission near the close of 1918. It is not hard to understand why Seattle is proud of what has been achieved in the face of many difficulties. An unfaltering determination to succeed has brought a well-earned reward.

SIGNAL SYSTEM MAKES FOR SAFER OPERATION OF HOISTS

AN electric signaling device for cage operations has been developed and put in service on the property of Oglebay, Norton & Company, Ironwood, Mich., that is said to be a model of its kind and to fill a long-felt want in shaft mining. Any mine electrician can install it economically either in the form of a one-way code-signal system or, as in the present case, of a combination code and two-way talking system.

By the use of the device it is impossible to signal to the engineer in the hoist room except from the cage, itself; but from that station, regardless of its position in the shaft or whether it be moving or standing still, the man in charge can transmit code or verbal messages at will. If for any reason the cage should become stuck, the system will instantaneously and automatically give the stop signal. Aside from the increased safety thus offered, the device also assures increased efficiency in shaft operations. The equipment was planned and installed under the direction of L. D. Stewart.



1—Gorge Power House about seven miles below Diablo Dam. 2—Two of the Westinghouse generators in the Gorge plant. 3—Diablo Dam blacksmith shop equipped with a No. 50 sharpener and a No. 25 oil furnace.

Putting Old Materials to New Uses

"RAGS, bones, old iron, and bottles!"

To a great many of us this time-honored cry of the itinerant junkman carries us back to boyhood days when the wandering buyer of waste materials broadcasted his approach and offered small sums for the commodities he sought. The junkman then represented the bottom of the ladder of barter and sale, and most people wondered how he found a market for the things he bought. Since those days the whole story of waste materials has been rewritten, and the people engaged in their handling now enjoy an entirely different position in the field of merchandizing.

The term industrial wastes embraces a multitude of commodities upon which work has been done to make them usable when new, and, because of this work, they retain a measurable value when classified as scrap. This is especially true of some metals and other substances that in their scrap form can be reworked for use again at less expense than was originally incurred in preparing them as raw materials for service. It is not our intention to do more than point out some of the many waste materials that are now bought and sold or so made use of in order to effect very substantial economies. This is one sure indication of how we have changed industrially since the days of the junkman of the past.

Until quite recently, scrap motor cars were a drug on the market and all too often a blot on the landscape. They accumulated until they became an unsightly aggregation, or they were dumped into any convenient hollow or utilized in making filled-in ground. Today, one big automobile manufacturer has devised facilities for pressing stripped cars into squat masses of steel that are shot into furnaces where they are promptly reduced to molten metal to form ingots that are again rolled into plates and shapes for reservice. In some departments of the lumber and the woodworking industries the scrap amounts to as much as 30 per cent of the raw material. For a goodly while these plants even paid to have the wood scrap taken away. At the present time, much of this waste is utilized as fuel in the generation of energy, and often the ashes have a commercial value as fertilizer or as a source of potash. Furthermore, the waste of certain woods is employed in the production of marketable chemicals.

Old bottles are put to a variety of uses as bottles, and to a degree this can also be said of discarded milk bottles; but probably the bulk of these containers is utilized in the making of glass that is again worked into bottles. Scrap glass of this sort is known to the industry as cullet; and a percentage of cullet in a fresh mix hastens melting of the associate raw materials and is otherwise a helpful ingredient. Waste paper, as most of us know, can be used in the production of other paper, and this obviates the employment of considerable quantities of pulpwood and new wood pulp. Savings amounting to a great many thousands of dollars are thus effected. The same story applies to numerous other nonmetallic scrap materials.

Cutting up the structural parts of an obsolete battleship preparatory to melting them in a steel mill.

It is a matter of general knowledge that old automobile tires and inner tubes, old hose, and a variety of other commodities containing more or less rubber, are harvested by the junkman, classified, and disposed of to concerns engaged in reclaiming rubber from such sources and making it fit for reuse. This business amounts to many thousands of dollars annually.

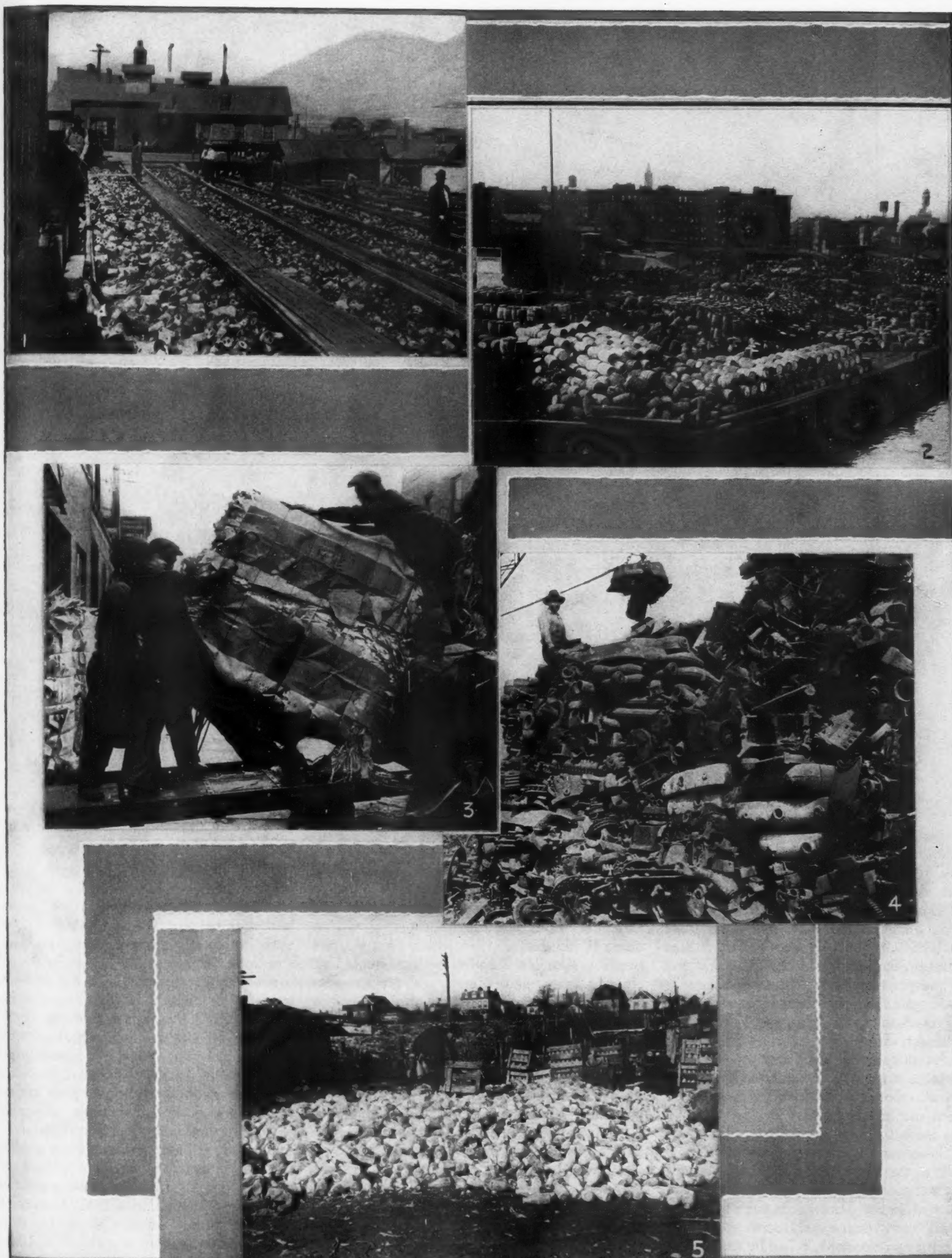
For a goodly number of years the water flowing from or pumped from copper mines found its way without any hindrance on man's part to the nearest creek, river, etc. Now, on carefully managed copper properties, the mine water is led through leaching tanks or flumes filled with all sorts of old iron or steel articles which serve to induce deposition upon them of cumulative films of metallic copper, thus recovering from waste water large and valuable quantities of copper. In the end, the ferrous metals corrode and disappear, leaving shells of the red metal. This is but one among many instances of the careful recovery today of metallic values that formerly were either permitted to dissipate themselves or helped to upbuild industrial dumps.

Each year, the United States Bureau of Mines publishes a report that deals with what are known as secondary metals—a high-sounding name for metal scrap. To quote from one of these bulletins: "Secondary metals are those recovered from scrap metal, sweepings, skimmings, and drosses, and are so called to distinguish them from metals derived directly from ores, which are termed 'primary metals'. This distinction does not mean that secondary metals are of inferior quality, because metals derived either from ore or from waste material may vary in purity and in their adaptability for use in the making of certain products."

Undoubtedly, scrap steel and iron constitute the major part of the trade in secondary metals; and the scrap-iron industry has long been a vast one and a vital part of the economic structure of the United States. It is estimated that the business in scrap iron and steel amounts to more than 30,000,000 tons annually, and represents a value of fully $500,000,000. Other scrap metals are brass, together with secondary copper, zinc, lead, tin, antimony, aluminum, and nickel. All told, the collecting, sorting, and shipping of metallic waste has a computed value of considerably more than $1,000,000,000 every twelvemonth. Dealers in secondary metals are an important source of supply of raw materials; and the proper use of these commodities brings about reduced costs in the making of a wide variety of new products.

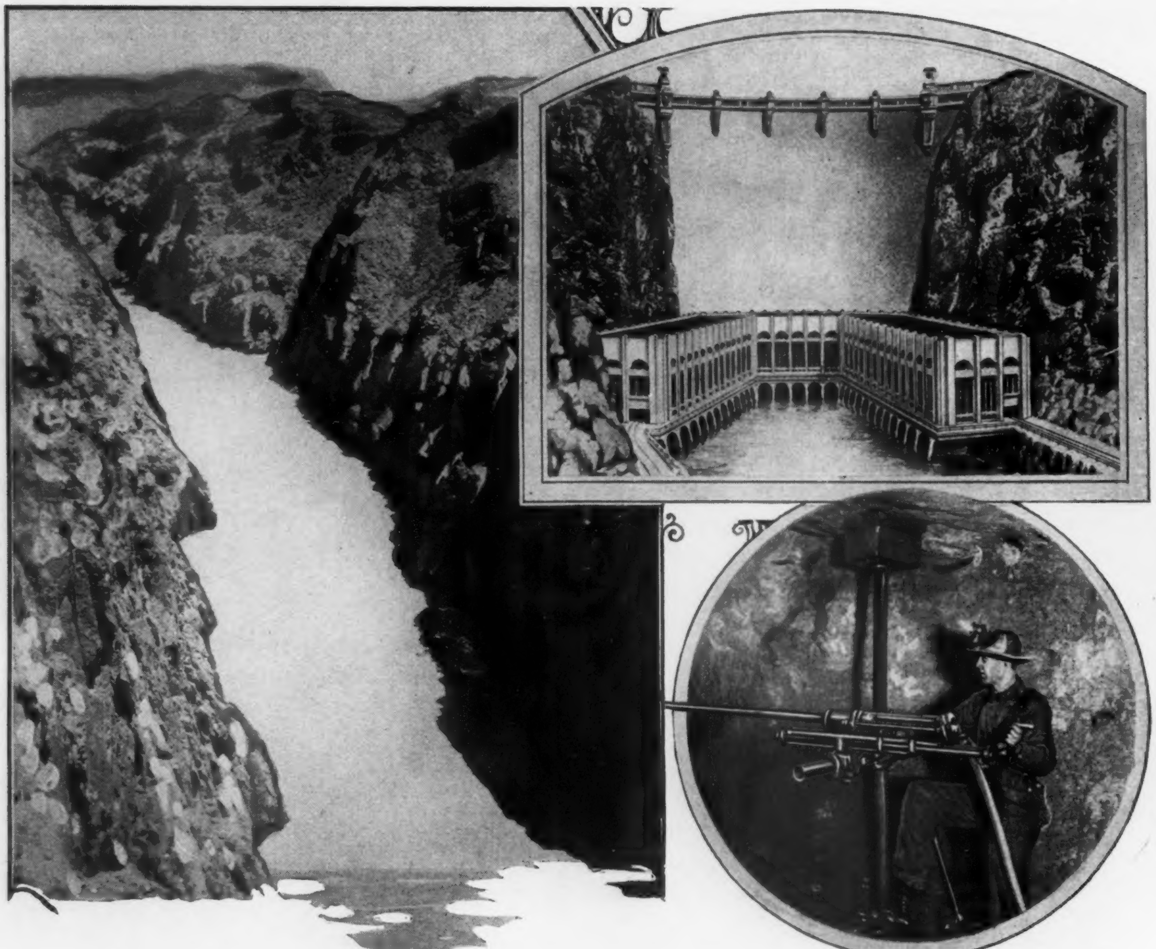
In the course of a single year one public-service company will collect 300,000 burned-out electric lamps; and by means of a machine the brass shells at the socket end are saved so that the metal can be melted up for reuse. A considerable amount of tin is regularly recovered from old cans and tin-plate scrap; and in the course of 1928 the reclaimed secondary aluminum totaled 47,800 tons valued at $23,469,600. The secondary nickel recovered from non-ferrous sources in the United States in the same year was equal to 13 per cent of the nickel imported. Again, in 1928, the output of secondary lead was equivalent to 39.5 per cent of the refined primary lead produced in this country—amounting to 308,600 short tons. Our automobile batteries contributed generously to that total.

As has been pointed out, it is important that the service life of metals be prolonged as far as possible, because when metals are once produced from the earth's crust they can never be replaced. Efficient as we are as a people in numerous directions, still we have until recently been woefully wasteful of our primary raw materials. The steps now taken to recover industrial wastes is the best evidence of an aroused consciousness of the economies to be realized through saving scrap and making it available for reuse time after time.



Ewing Galloway, New York

1—Discarded cans used to collect copper by precipitation from mine water. 2—Old barrels in great quantities are reclaimed and sold after coopers have made them fit again. 3—Waste paper on its way back to the mills for reworking. 4—Some of the scrap iron and steel involved in a business valued at $500,000,000 annually. 5—There is a ready market for scrapped milk bottles either for refilling or for reworking into new containers.



View at left shows the site of the Hoover Dam on the Colorado River between Arizona and Nevada. At the upper right is an artist's conception of how the completed dam and the power houses will appear. In the circle is one of the various types of air-operated drills that will be used to help excavate the immense quantities of rock that will have to be removed.

Ingersoll-Rand Compressors and Drills To Be Used on Hoover Dam

SIX Companies, Inc., of San Francisco, Calif., which has been awarded a contract of nearly $49,000,000 by the United States Reclamation Service for building the Hoover Dam, has placed orders with the Ingersoll-Rand Company for air compressors and rock-drilling equipment for this record-breaking 5-year undertaking.

The stationary air-producing plant will consist of a battery of Class PRE, direct-connected, electrically driven compressors having a combined capacity of 25,000 cubic feet per minute. These machines will supply air for the driving of the four diversion tunnels that are to carry the waters of the Colorado River through the canyon walls around the dam site while the dam, itself, is being built. Work will start immediately upon these tunnels; and they are scheduled to be completed within eighteen months.

These rock tunnels are especially interesting because they will be the largest ever driven for comparable distances. Each will be 57 feet in diameter and 4,000 feet long, about seven times as great in cross section as such railroad bores as the Moffat and the Cascade. Four tunnels almost as large as either of the Holland Vehicular Tunnel units between New York and New Jersey could be placed in any one of them. An average-size, 5-story house could be moved through one of them without scraping the sides or roof. A total of 1,563,000 cubic yards of rock will have to be excavated in driving them.

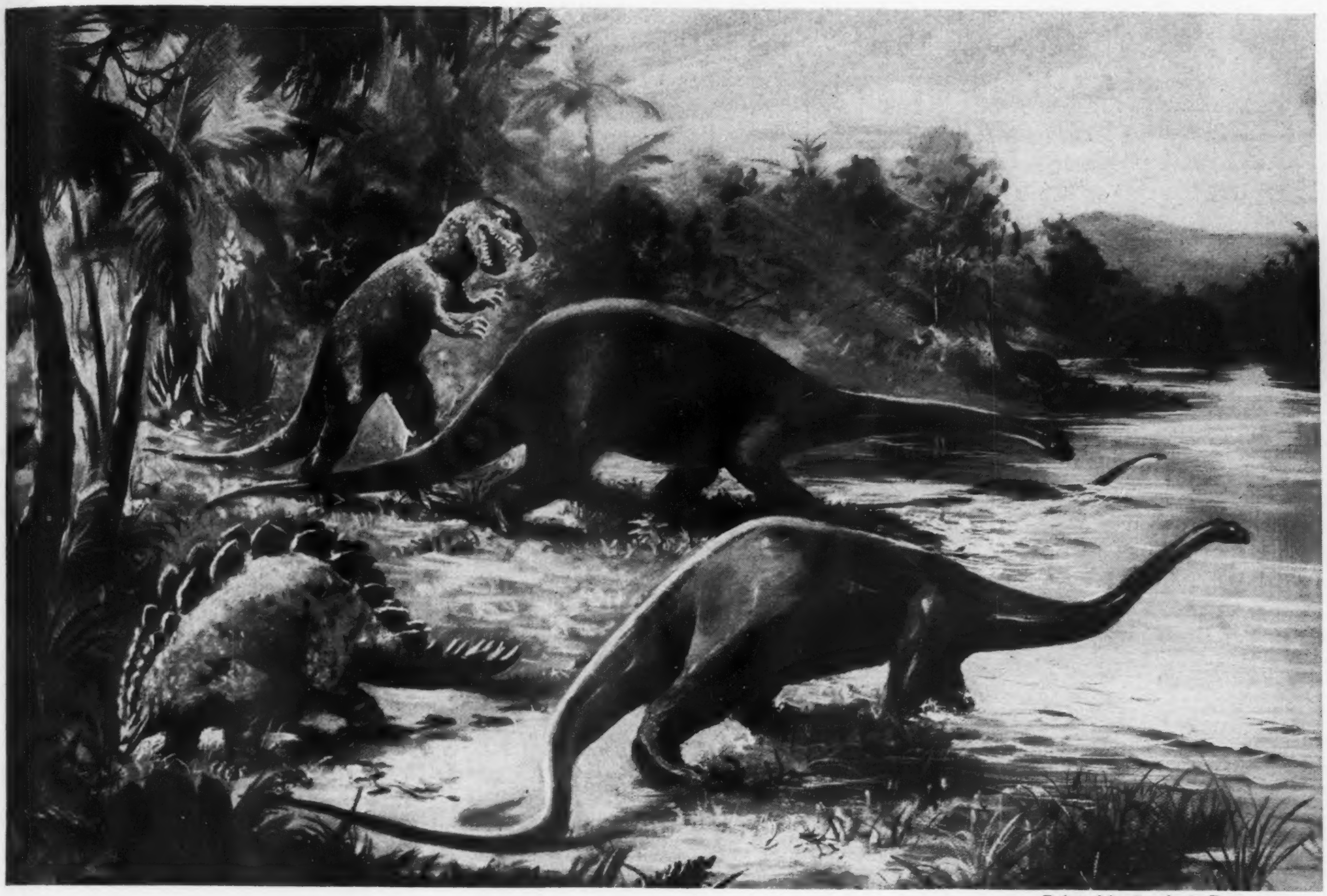
The exact method of drilling the tunnels probably will not be determined until more has been learned about rock conditions after a start has been made. Because of the size of the openings, the work might be classed as quarrying rather than tunneling. There will be ample room to drill, muck, and load the spoils without working in cramped quarters. Because there is no space available in the river bottom for dumping, all the excavated material from the tunnels will have to be elevated up over the canyon walls for disposal.

When the river has been diverted past the dam site, excavations will be started for keying to the solid rock of the canyon sides and bottom the great arch of concrete that will rise 727 feet above bedrock. A year and a half will be required to pour the 3,600,000 cubic yards of concrete that will bring the stream under control.

All told, approximately 5,800,000 cubic yards of rock will have to be removed in connection with the entire undertaking. Preliminary estimates indicate that about 8,000 miles of drill holes will be required in getting out the rock involved. Hundreds of tons of drill steel will be literally worn out in penetrating the breccia rock formation that makes up the canyon walls and the river bottom.

So great a basin will the dam create that eighteen months of normal river flow will be required to fill it. The resulting reservoir will have a surface area of 193 square miles and will contain enough water to cover the State of Connecticut to a depth of 10 feet.

In addition to the compressed air to be furnished by the stationary plant, Ingersoll-Rand portable compressors will supply air for the rock drills to be used in scaling down the canyon walls on either side of the dam site to guard against rock slides.



Painted by Lewis A. Ramsey

A scientist's conception of a typical scene in the dinosaur country of western America. At the left in the background is an Allosaurus and at the right a Brontosaurus. At the lower left is shown a Stegosaurus and at the right a Diplodocus.

Dinosaurs of Western America

By DR. FREDERICK J. PACK*

DINOSAURS were gigantic reptiles. They belonged to the same group of animals as alligators, crocodiles, and lizards. Indeed, the term dinosaur means "terrible lizard". Dinosaurs made their appearance approximately 120,000,000 years ago at a time when both life and geography were very different from what they are at present; and then, after enduring for roughly 80,000,000 years, they became extinct.

In order to obtain a proper perspective of the part these creatures played in the drama of earth history, let us attempt a kind of kaleidoscopic summary of the principal forms of life that have inhabited the earth from the beginning to the present. Or, perhaps better, we might attempt to compress the 500,000,000 years during which life is known to have been upon the earth into an ordinary day of twelve hours.

At the dawn of this imaginary day animal life had already appeared. From whence it came, no one knows. It consisted of minute organisms, living in the sea, chiefly microscopic in size and of extremely simple structure. The land was devoid of both plants and animals, and, therefore, of a barrenness bewildering in its simplicity.

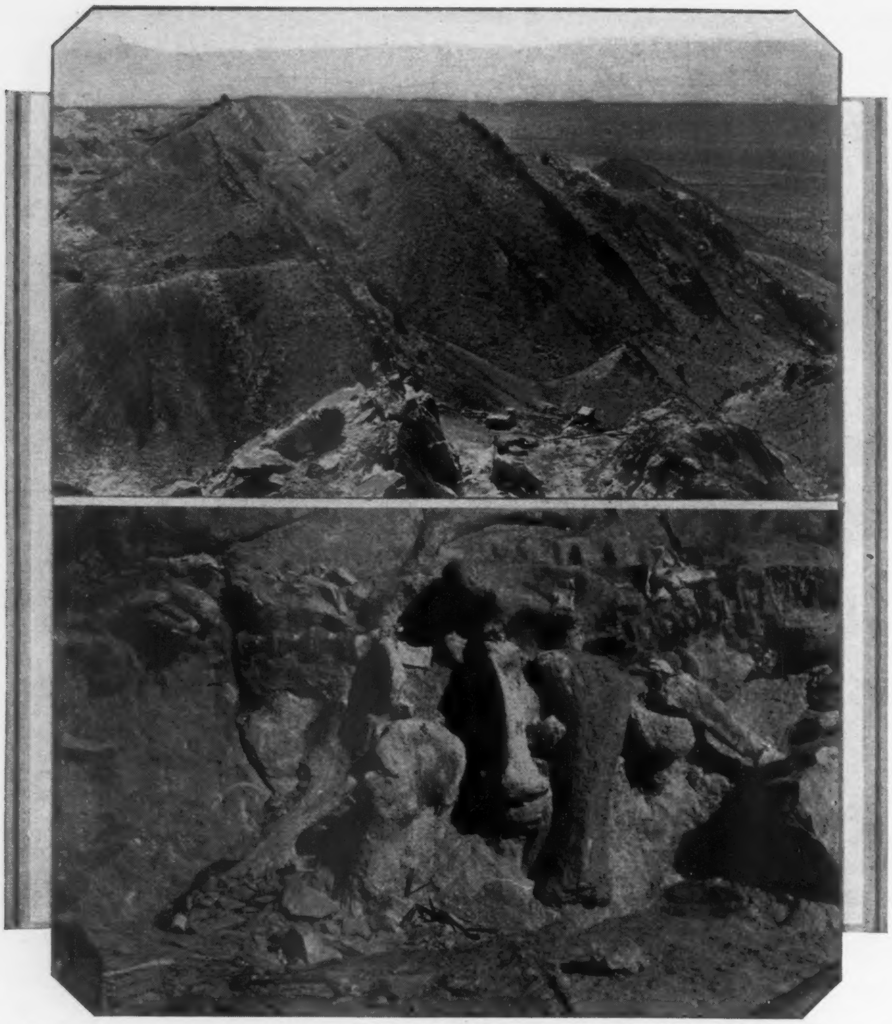
*Deseret Professor of Geology, University of Utah.

By 10 o'clock in the morning the original creatures had given place to much more complex ones not radically unlike modern corals and clams. At noon fish came into existence, and, slightly later, plants and primal forests. At 1 p. m. small slimy creatures crawled from the sea and took up their abode within nearby swamps and boggy lowlands. These were the amphibians, which can live both within water and upon land. Later the amphibians became exceedingly abundant, and in some cases very large and hideous. Individuals 10 to 15 feet in length were not uncommon. This well-nigh extinct race of formidable monsters is now represented by a few diminutive creatures such as frogs, toads, and salamanders.

Two hours later came the dinosaurs, virile and aggressive. After they had subdued their comparatively docile enemies, the amphibians, conflicts arose among them, and the various factions developed a high degree of both offensive and defensive warfare. This condition lasted for several million years, and then, almost promptly at the stroke of five, the entire dinosaur family disappeared, perhaps even more rapidly than it had arisen. Thus at 5 o'clock the dinosaurs were replaced by mammals in much the same manner as they themselves had replaced the amphibians. The new race became dominant in a comparatively short time. At the beginning of this period horses were minute 4-toed creatures scarcely more than 12 inches high; whales were small land-living animals; and elephants were slightly larger than modern pigs. It is from this humble source that our present race of mammals arose. Moreover, the task which was begun at 5 o'clock was finished at six, the point at which we now stand. What the future has in store is difficult even to surmise.

It is interesting to observe that although dinosaurs were extant for a very long time as measured in years, yet, as compared to the period that life has been present upon the earth, their existence was really brief. In the light of this information it is also well to note that they were comparatively recent creatures even though they disappeared from the earth probably not less than 40,000,000 years ago. Geological time is certainly an elusive subject with which to conjure.

Parenthetically it should be stated that it is fortunate for the various forms of life that lived upon the earth that climates and geography have not forever remained constant, otherwise it is not improbable that a single



Top—Dinosaur quarry in foreground. Note how rocks, formerly horizontal, are sharply tilted upward. Bottom—A fine array of bones uncovered in the quarry face. The large bone standing upright is nearly 6 feet long.

group might have adapted itself to prevailing conditions and continued on indefinitely. But, with the somewhat frequently changing environments that have characterized earth history, creatures of a wide variety of habits have been permitted to experience periods of dominance and decline.

There is reason for believing that primitive reptiles, from which dinosaurs arose, probably lived exclusively in swamps, and that within this environment they multiplied rapidly and soon overpopulated their highly limited habitat. Certain of the more aggressive creatures possibly ventured into deeper water and gradually acquired the ability to live and propagate within it. From them came a group of reptiles that flourished in the open sea and assumed the external form of true fish.

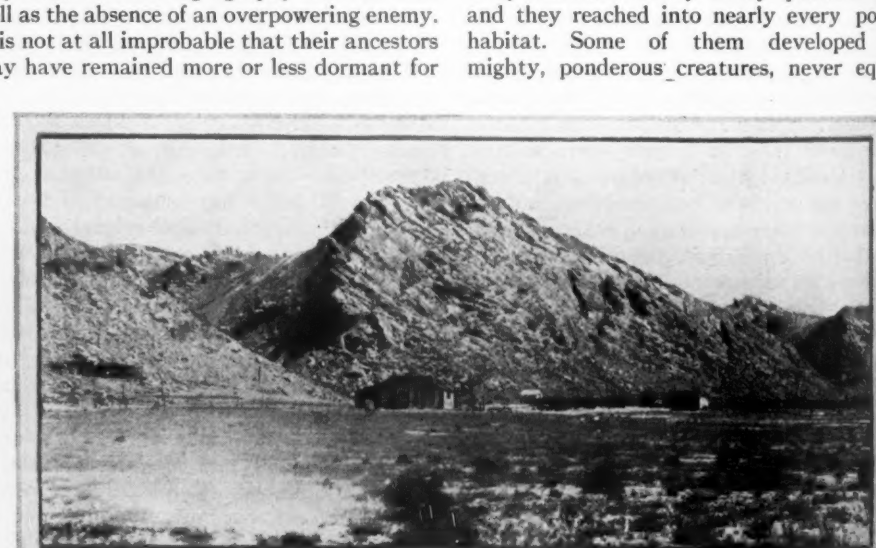
Others of the early reptiles developed the skill to move about in the air, and, in the course of time, gave rise to a race of flying creatures truly reptilian in structure but birdlike in outward appearance. The wings were covered with a membranous substance rather than with feathers. A fossil of one of these creatures, which had a wing spread of nearly 20 feet, was recently found. Still others are believed to have left their swampy homeland and to have gradually adapted themselves to a life upon the open ground. Some of them became extremely large. It is to this group—the dinosaurs—that we must confine our principal attention.

Dinosaurs, like all other creatures, necessarily developed to best advantage only within a favorable environment, which probably included both geography and food as well as the absence of an overpowering enemy. It is not at all improbable that their ancestors may have remained more or less dormant for a long time before a favorable combination of conditions actually arrived. But, when the opportunity finally came, the ascent of the dinosaur was rapid, as the geologist measures time. The record shows that they appeared with remarkable abruptness and that, in a surprisingly short time thereafter, they attained full supremacy over their natural enemies, the amphibians.

It has already been noted that dinosaurs arrived in the mid-afternoon of geological time, and that they succeeded amphibians and preceded mammals. Let us now turn to a consideration of the region in western America where they developed in great numbers and where some of them attained colossal size. Unfortunately, the limits of the present paper do not allow us to follow these interesting creatures into other countries.

Long before the Rocky Mountains appeared, the country in which they are situated comprised a vast elongated valley the bottom of which, in places, was only slightly above the level of the sea. This valley stretched more or less continuously from the Gulf of Mexico to Alaska. Immediately adjacent to it, on the west, the Nevada region constituted an extensive mountainous uplift, while the terrain to the east was lower and more rolling. In short, it was bounded east and west by uplands of sufficient height and extent to contribute plentiful streams of water, large as well as small. Numerous rivers led down from its upper slopes, and an even larger number of lakes, both fresh and saline, were in the lower parts of its floor. The streams and fresh-water lakes were fringed with shrubs and trees, while the open spaces were blanketed with grasses and smaller plants. This was a typical dinosaur country. It was there that they arose, there that they gained their ascendancy, there that they reigned supreme for roughly 80,000,000 years, and there that they declined and disappeared.

With perhaps the single exception of the mammals of today, no mightier race of animals has ever lived than the dinosaurs. They attained nearly every possible form, and they reached into nearly every possible habitat. Some of them developed into mighty, ponderous creatures, never equaled



Barren region near Jensen, Utah, where dinosaur bones were found in canyon at the right.

before or since by land-living animals, and others acquired the agility and running speed of the modern antelope. Some of them lived in the water, others upon the land. Some of them ate flesh, others vegetation. Some of them walked upon four legs, some on two legs, and others were able to leap great distances through the air.

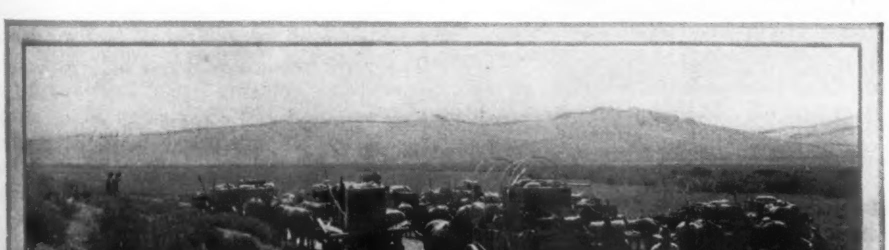
Nature, in a subtle and mystifying manner, somehow permits many of her creatures to become nicely adjusted to the environment in which they live and to the duties that they have to perform. In this respect, her efforts appear to be limited by only two requirements, namely, that each creature shall be able to obtain a livelihood and to protect itself against its natural enemies. When the dinosaurs, therefore, found themselves in the midst of a favorable environment, they at once set about to make the most of it. Some of them settled along streams, where living conditions required the least effort. Others chose marginal areas, and still others went out on to open plains where food and water were far apart. Those that settled near streams developed ponderous bodies, which, because of their formidable size, were a sufficient guarantee against ordinary attack. On the other hand, the creatures on the plains necessarily relied upon fleetness of foot for both food and protection.

The public has manifested most interest in the water-loving dinosaurs, chiefly perhaps because of their almost unbelievable size. It is difficult to imagine an animal seven or eight times as large as a modern elephant, and yet some dinosaurs reached such proportions. The mighty *Brontosaurus* is believed to have weighed when alive between 35 and 40 tons, while a few others were probably larger.

Top—Forty-five tons of dinosaur bones boxed and ready for the journey to Salt Lake City. Bottom—A new dinosaur quarry which will be exploited as soon as weather conditions permit.

These gigantic creatures, except for the fact that their bodies were mounted on relatively long legs, were remarkably lizardlike in form. They attained a length of 65 to 90 feet and a height of about 15 feet midway between the front and hind legs. Their stomachs were sufficiently raised from the ground to have permitted a modern man to stand nearly upright beneath them; their necks and tails were extremely long; and their heads were ridiculously small. The brain was scarcely larger than the human fist. Indeed, it is true that they had but little need for such an organ, since food was abundant and they were too big to be successfully attacked by most of their enemies. If they were sorely pressed, they could usually escape by tumbling into nearby water.

The chief enemy of these mammoth dinosaurs is believed to have been a somewhat smaller one of carnivorous nature, known as the *Allosaurus*. The earth has produced but few more vicious and terrible creatures. It weighed as much as two or three modern elephants, and was possessed of tremendous strength and powerful organs of attack. Its head was more than 3 feet long, and its jaws were provided with a battery of sharp, backward-curving teeth as large as a human finger. The animal walked on its hind legs and balanced itself, while at rest, by means of an enormously developed tail. The front legs were very small and were used principally as prehensile organs to help the creature hold its prey. Its feet had catlike claws 6 to 10 inches in length.



The caravan halted for a noonday rest. The men cooked for themselves and fared well.

The *Stegosaurus* was an awkward, senseless sort of animal of herbivorous nature. Its legs were short, its back was arched high in the middle, while its neck and tail descended close to the ground. Its entire vertebral column, from head to end of tail, was mounted with a double row of great upright plates, while the extreme end of its tail was provided with an assemblage of gigantic spikes, each nearly 2 feet long. These appendages appear to have been the creature's principal means of defense. When it was attacked it probably concealed itself beneath its platy covering, meanwhile desperately swinging its armored tail.

No one knows what was the normal life span of a dinosaur; but, when dead, an occasional carcass was picked up by the larger streams and swept onward toward the center of the valley. It is now definitely known that a sand bar extended across the course of one of these rivers, and this halted the drifting carcasses of the bigger dinosaurs and caused them to become stranded in the shallow water. Year after year, and possibly age after age, bodies of other dinosaurs were brought to the same place until, finally, it became the greatest dinosaur graveyard yet known to the scientific world.

Top—"Uncle" John Kay leading the procession of nineteen wagons while climbing the Great Basin Divide. Bottom—The caravan crossing a mountain meadow. Note that most of the wagons have four horses.

It has also been discovered that while the bodies of these huge creatures were balancing on the shallow sand their long necks and tails were turned down the current like willows held in a stream. Thus most of the heads became detached and drifted away so that it is now a rare experience to find a skeleton with the head present. In the case of a magnificent *Allosaurus*, recently recovered by the University of Utah, the head was in place because the neck had been twisted back on itself when the body was jammed between two larger ones. Few of the smaller dinosaurs have been found in this motley gathering, possibly because the water was sufficiently deep to permit their bodies to pass over the sand bar.

With only minor variations in their geographical environment, the dinosaurs were practically unmolested for millions of years. But eventually the valley in which they lived was slowly submerged beneath the sea, and, as a result, many of the groups became extinct and others moved elsewhere. The writer does not propose to offer an explanation for their disappearance, primarily because he does not know of a satisfactory one. Various suggestions have been made—the most popular one being that the oncoming mammals ate the eggs of the dinosaurs and thus prevented further propagation. This explanation, however, is probably more poetical than meritorious. The true cause doubtless lies in a combination of agencies, chiefly, perhaps, change of geography and climate, together with the unknown factor in nature that sometimes appears to urge living forms on to a completed development and then abandons them.

After the submergence, the ancient valley was covered by the sea for so long that the dinosaur remains, which had accumulated on the old sand bar, were eventually buried to a depth of more than two miles—surely, one would think, beyond the remotest possibility of their subsequent appearance at the surface. In the meantime, the sand and mud which had surrounded them were converted into solid rock, and, of course, all signs of the ancient river were lost, except, perhaps, to the trained eye of the specialist.

Then another geographic change occurred. The Rocky Mountains arose from the sea at the site of the submerged valley, and an uplift was formed in the immediate vicinity of the ancient river. These were the Uinta Mountains of northeastern Utah. The formations of this range were bent upward into an enormous fold more than 100 miles long and half as wide. Simultaneously, eroding agencies cut deep ravines and canyons into it. This devastating action continued for ages until, in fairly recent times, it penetrated the dinosaur burial ground and actually exposed a few of the bones.

Then man appeared upon the scene in the person of Mr. Earl Douglas, who had been sent out by the Carnegie Institute of Pittsburgh to look for dinosaurs. His work brought him to a rough mountainside near the Village of Vernal, in northeastern Utah, where he discovered a few bones protruding from a heavy, almost vitreous sandstone. Up to that time his efforts had not been rewarded by any important discoveries and he therefore decided to dig out the bones. One can imagine his delight when he learned that the outcropping bones led to others, and still others, and then to complete skeletons. The Carnegie Institute pursued its work there for some thirteen years, and found and removed the remains of nearly a score of dinosaurs.

Meanwhile, the University of Utah applied to the United States Government for permission to continue operations, and eventually it was granted. From the outset, the Utah group was seriously handicapped by a shortage of funds. When the field work was begun, less than $2,000 was available; but, through the unfailing coöperation of Pres. George Thomas, other considerable amounts were subsequently added. Even so, some six months later, abandonment of operations was enforced because of a lack of money. The work was called to a halt just as the partial skeleton of a great *Brontosaurus* had been removed and when many of the remaining parts were exposed. These, however, were carefully covered with plaster of Paris and otherwise protected from the weather. Scarcely a year thereafter a rock slide occurred in the quarry and covered them to a depth of 20 and more feet. Thus, the remaining parts are still resting under this heavy burden, awaiting the day when they will be dug out and reassembled "bone to bone" with the others now at the University of Utah.

The university had set out to discover a single creature, but, in the words of its president, it found "a whole herd". Four more or less complete skeletons were excavated, boxed, and made ready for shipment. The

total mass weighed 90,000 pounds. It should be remembered that no effort was made at the quarry to separate the bones from the rock, since this work could be done much more expeditiously in the laboratory. Of the 45 tons probably half was rock.

The distance from the quarry to the university, at Salt Lake City, is 225 miles, less than half of which is traversed by railroad. It was, accordingly, decided to transport the material by automobile truck, for which a satisfactory haulage rate was obtained. Then an interesting thing occurred. A stalwart man of seventy stood before a group of his friends at the post office in Vernal. When an agreement was reached he came forward and asked to be given the contract for hauling the dinosaurs by wagon to Salt Lake City. "Why, Mr. Kay", replied the man addressed, "you can scarcely hope to live long enough to complete a job of this magnitude". But "Uncle John" confidently explained that twenty of his friends had agreed to join him in the task, and that, if the contract were awarded to him, a sufficient number of wagons to convey the entire lot would be ready the next morning. His proposition was accepted largely because his charge was considerably lower than any previously quoted.

The loading consumed but a single day, and the following morning the greatest funeral procession of all time started out over a mountainous country for the University of Utah. People came from far and near to see the dinosaur caravan; and when it reached Salt Lake City, exactly seven days later, it was met with acclaim befitting a king. Business houses were temporarily closed, people lined the streets for miles, and a cordon of police headed the procession as it passed on to the university.

During the time the dinosaur quarry was being operated, and more particularly when the cortege was approaching its destination, the writer, who was in charge of the work for the University of Utah, was literally bombarded with questions concerning the size of the dinosaurs, their weight, their age, the years that had elapsed since their disappearance, etc. One evening, as I sat at the family dinner table, I was called to the telephone, and a somewhat irate woman asked me how long ago these particular dinosaurs had lived. Upon my reply, "About 80,000,000 years", she wanted to know if I were a Christian, and, if so, how I reconciled my attitude with the story of Genesis. I explained in some detail that I am a believer in the Bible and have never discovered any worthwhile differences between its account and that recorded in the rocks. Upon my return, I related to my family the seeming predicament of my unknown inquisitor, and a general discussion of the subject followed. A few minutes later my elder son, then in his late teens, left the table, and a half hour thereafter returned with the following jingle.

"It seems to me that Noah's boat
Was taxed most sore to keep afloat,
For now we know he had to park
Two dinosaurs upon his Ark.

When one big boy would wag his tail,
Poor Noah's bus just couldn't sail,
Or if, perchance, one had to cough,
He'd nearly blow all others off.

Then Noah sat and bowed his head
Till in despair he rose and said:
'You boys are far too big for me;
I'll have to chuck you in the sea.'

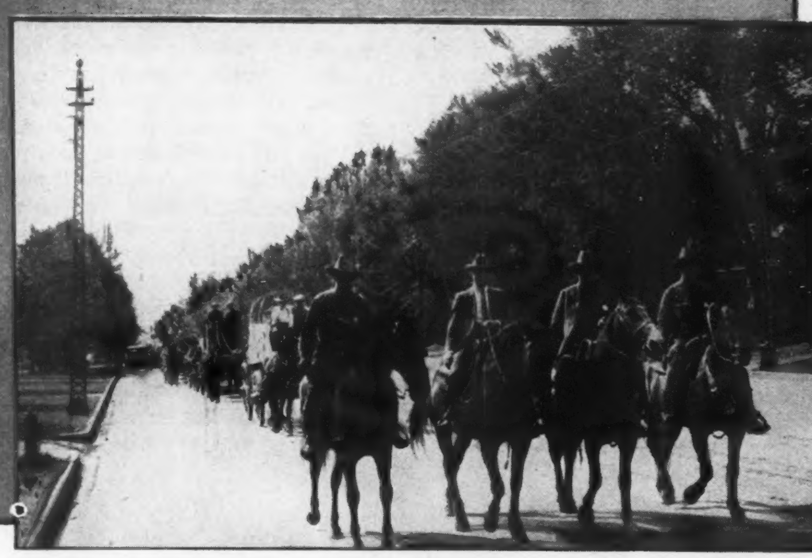
As over Vernal, Noah stopped,
Two dino's overboard he dropped.
Down they sank with moistened thud,
And soon were buried in the mud.

Aeons fled, our land 'went dry',
And years by millions passed them by.
Till in our day, and after ages,
They've been unearthed by wise old sages.

Now—on the hill above our town—
They'll stand forever, looking down,
With sadness in their stony eyes,
Because the Ark was small in size."

The University of Utah points with pride to the fact that it has a larger collection of dinosaurs than any other university or college in the world. Moreover, its pride is intensified because these gigantic creatures really belong to Utah—they are truly native sons.

In 1929, a party under my direction discovered a new dinosaur deposit in another section of the state, but not until the latter part of the season, just closed, were serious efforts made to exploit it. The partial remains of half a dozen dinosaurs, some no longer than a cat and others fully 50 feet long, had been removed when an early snow drove the workers from the field. The deposit gives promise of being even more prolific than the old one.

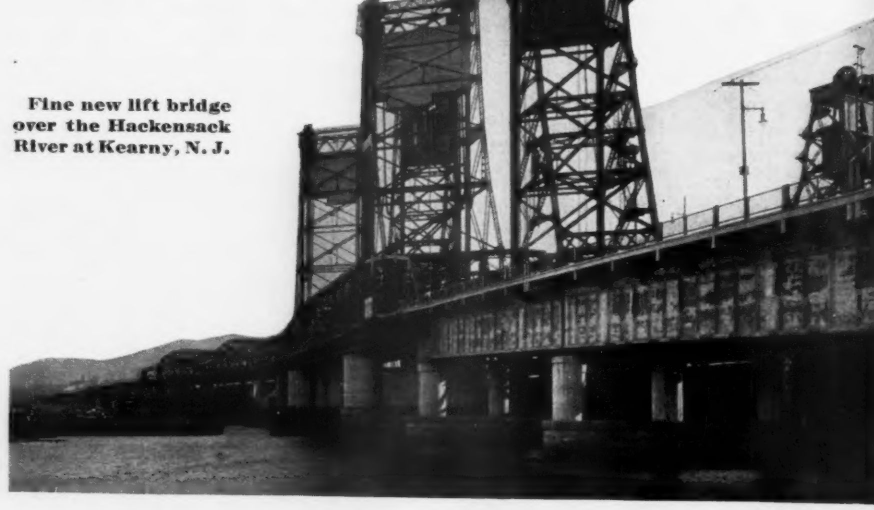


Top—Resting for a while when but a day's journey short of Salt Lake City. Bottom—Headed by a cordon of police the procession was escorted through Salt Lake City to the grounds of the University of Utah.

A Norwegian company is experimenting with aluminum for foodstuff containers because of the lightness of the metal, which means reduced freight rates, and because aluminum can be reclaimed for reuse far more readily than can tin, now commonly employed for that purpose. The company has produced 50,000 such cans, bearing in embossed letters a designation of their contents. Although the price of aluminum is higher than that of tin, it is believed that the saving in labels and glue, not to mention the work incident thereto, will more than offset the difference in cost.

Rapid and Effective Demolition of Old Bridge Piers

By E. H. PAULL



Fine new lift bridge over the Hackensack River at Kearny, N. J.

THE removal of the piers that once supported the Newark Turnpike Bridge over the Hackensack River at Kearny, N. J., attracted unusual attention among contractors as well as the general public. The traveling public was arrested by the rat-a-tat-tat of three large hammer drills that successfully ate their way into the concrete that had withstood the erosive action of the elements for the past twenty years; and the gaze of the passing thousands was also centered on the men and machines perched upon the piers in the middle of the stream with only a catwalk, composed of narrow planking, connecting them with the shore. The interest of the contractors, however, was of a different and a more serious character. They were primarily concerned with the progress made by the drillers and with the method of demolishing the piers, which were set in 30 feet of water.

The problem of drilling in and under water in the metropolitan district of New York and New Jersey has been given considerable thought during the past ten years. The continual deepening of channels and the removing of rock ledges and other obstructions from the bottoms of fairways have resulted in careful study to determine the most effective, the quickest, and the cheapest method of doing the work.

Private firms and the United States Army Engineers have carried on investigations and experiments with that end in view. The Army Engineers have succeeded in deepening the channel of the East River, New York, by using a sounding bar, attached to a scow, to locate the high spots and by employing divers to get rid of them with hand-held air drills. While the drills operated satisfactorily and efficiently under 32 feet of water, the divers were greatly handicapped in their work because of their inability to see in the dirty water. It was necessary for them to feel each ledge to determine its size, to drill the holes in total darkness, and then to relocate the holes so as to load them preparatory to blasting.

Some of the contractors engaged on jobs of this kind in and around New York Harbor employ drill boats. With the older type of submarine drill boat—steam operated, the drill remains above water, and long lengths of heavy steel are needed to reach down to the rock to be broken up. The modern submarine drill utilized for this purpose is more efficient and more positive in its action. It is air operated; it uses short lengths of steel; and it is lowered into the water close to the working face.

Barge being loaded with pieces of concrete recovered from river bottom after shooting one of the old piers.

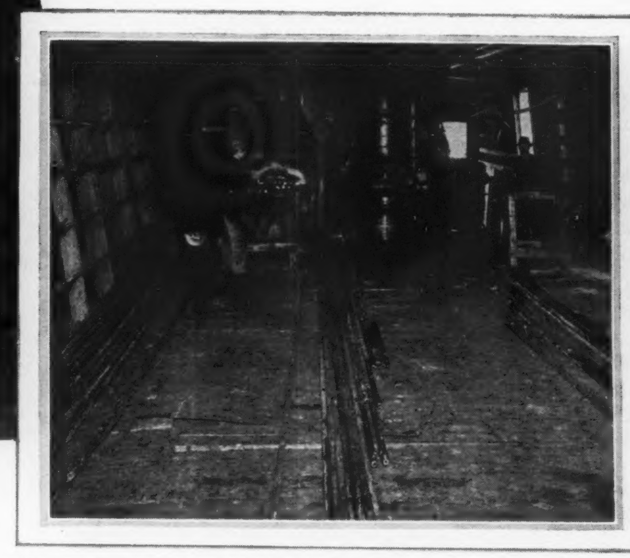
To get back to the pier-removal job at Kearny, it might be said that the great interest shown by contractors in the undertaking was probably due to the fact that comparatively little success has been achieved in the past in this class of work. Some of them have learned to their sorrow that it did not pay to drill and to blast off the tops of piers and then to continue their demolition by drilling and blasting successive rounds of holes.

Back in the early part of 1927, the Great Lakes Dredge & Dock Company, in coöperation with engineers of the Ingersoll-Rand Company, removed the concrete piers of a railroad bridge across Newark Bay by the use of hammer drills mounted on tripods. A series of 30-foot holes was drilled, and the entire pier shot at once. This method was, without a doubt, the most successful attempted up to that time.

At Kearny, the Gray Engineering & Construction Company of Greenwich, Conn., who did the job, followed the same general line of procedure just referred to. They did, however, make a few changes that have further speeded up the work. In place of tripods they utilized quarry-bar mountings and an improved arrangement for handling the steel and blowing the holes. The quarry bar not only added rigidity to the set-up but it made it easier to drill all holes in a straight line and to space the holes exactly. And to drill a complete round of 35 holes, it was necessary to move the set-up only twice.

Each pier had a height of 38 feet, and rested upon a timber foundation which was banked by riprap consisting of large boulders. A total of 35 holes was drilled per pier—the holes being spaced on 4-foot centers with an interval of 3 feet between rows. The work was carried on in two 8-hour shifts, and each drill put down two 37-foot holes per shift.

The drills in service were Ingersoll-Rand X-71 machines with 42-inch feed. They were of the double-tube type, which gives maximum blowing and cleaning action. This was augmented by the occasional use of a special blowpipe and of a $\frac{3}{4}$-inch wash pipe through which water was forced under a pressure of 100 pounds to keep the holes clear. These pipes were held in a convenient position above the drills



Left—Floating blacksmith shop of the Gray Engineering & Construction Company in which drill steels were made fit for their work of demolition. Right—Various lengths of drill steel conditioned by a No. 25 oil furnace and a No. 50 Ingersoll-Rand sharpener.

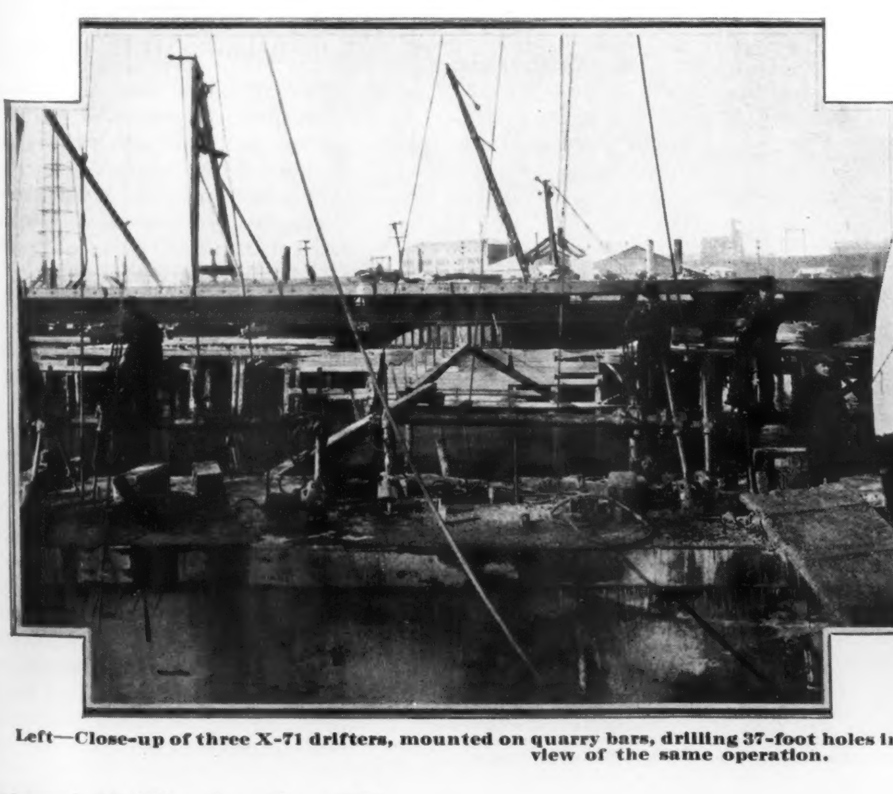
by an overhead cable that also carried the block and tackle required to handle the long lengths of steel. Lubrication of the drills was continuous, and was provided by air-line lubricators of the "D" type.

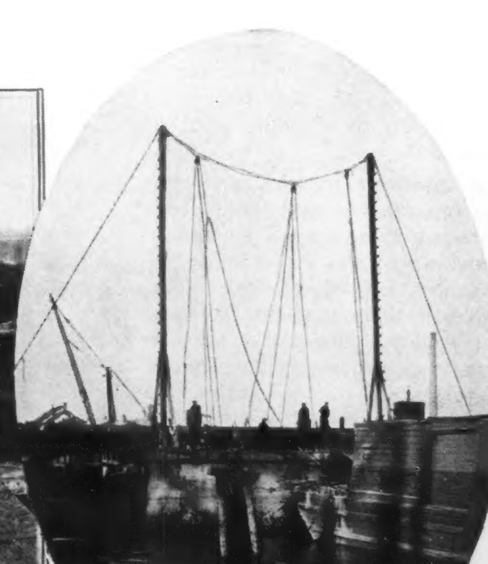
Hollow, round, 1¼-inch steel was employed, and this was made up in 39-foot sets with 3-foot changes. The starter bits were 3½ inches in diameter. This was reduced ⅛ inch with each change of steel until the hole was bottomed at 1¾ inches. The steel was reconditioned in a floating blacksmith shop equipped with a No. 50 sharpener and an I-R oil furnace. A No. 8 pedestal grinder was also available for truing up any uneven shanks. Air for the different requirements was furnished by three portable compressors which were stationed on the same barge that carried the blacksmith shop. Air at 90 pounds pressure was supplied to the drills.

Of the four piers that were removed three were 50 feet long and 8 feet 6 inches wide on top and 60x16 feet at the bottom. The pier on which the draw of the bridge rested was circular in form and had a diameter of 40 feet. This was the last to be destroyed, as it was necessary first to clear away the steelwork. This was done by the John E. Smith Wrecking Company of New York City.

Drilling was started about January 1, and on the 11th of that month Pier No. 2 was shot. Two 50-pound cases of powder were put in each hole—60 per cent powder being used for the bottom holes and 40 per cent for the top holes, with tamping between the two. The results of this first shot and the three that followed were very satisfactory. Each pier was completely shattered, and the pieces were of a size that could be conveniently handled both by clam-shell and orange-peel buckets.

The Gray Engineering & Construction Company has for years been engaged in submarine and harbor work, but the removal of the concrete piers of the Newark Turnpike Bridge was the first job of the kind they have ever undertaken. Mr. Phillip Gray is president of the company, and Mr. A. G. Lord, superintendent, was in charge of the operations at Kearny.

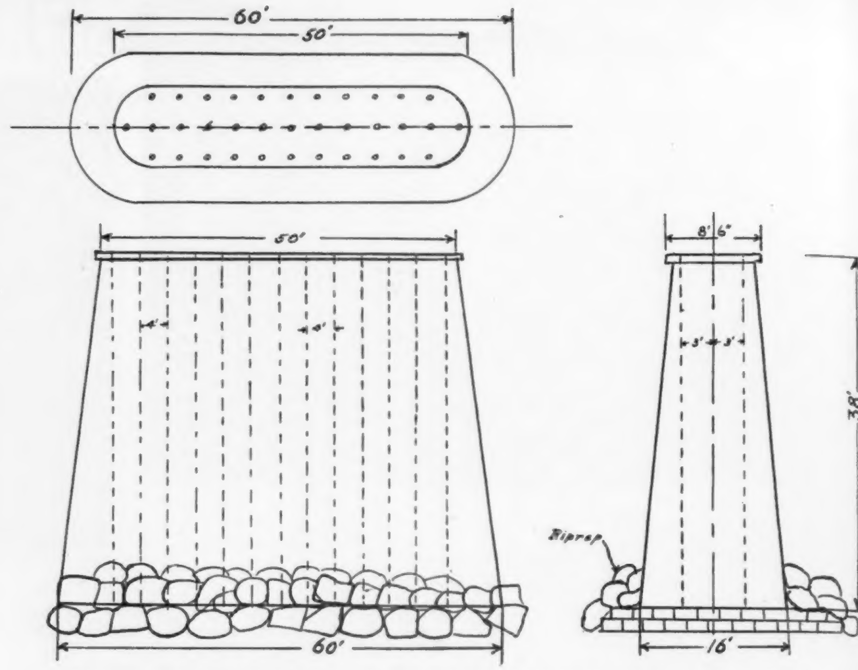




Left—Close-up of three X-71 drifters, mounted on quarry bars, drilling 37-foot holes in one of the concrete piers. Right—Another view of the same operation.

Much care had to be exercised in the demolition of the piers as the new highway bridge across the Hackensack River was very close to the scene of the blasting operations. That bridge is an important link in a much traveled state road between Jersey City and Newark, and was built by the New Jersey State Highway Department to take the place of the old through-truss structure that was for a long time a source of traffic congestion because of its poor alignment and its narrow roadway.

The bridge recently finished has a roadway 40 feet wide and two sidewalks each 8 feet wide. Including approaches, it has a length of 3,600 feet and is of steel and concrete construction. All the steelwork below the concrete roadway slab on all spans except the lift is encased in gunite, which was applied pneumatically. The vertical-lift span is 206 feet long and has a clearance at mean high tide of 35 feet when closed and of 135 feet when open.



Plan and elevations of three of the old bridge piers that were successfully removed by blasting.

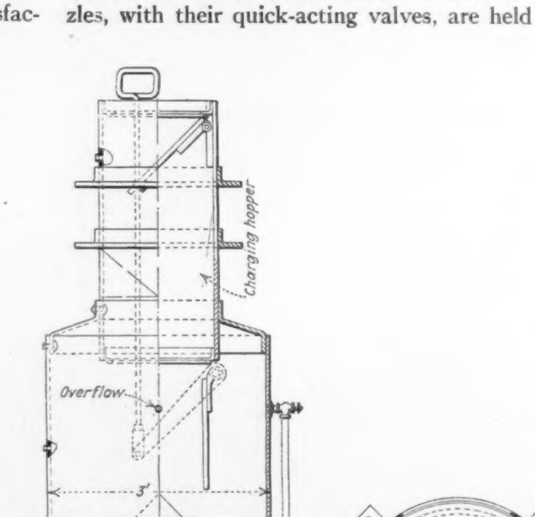
FUEL ASH PUT TO USE CLEANING CONDENSER TUBES

THE engineers of the East River Station of the New York Edison Company have had considerable difficulty in the past in keeping the condensers clean because of the proximity to the condenser circulating-water inlet of the outlet of one of New York City's trunk sewers. Material from this source finds its way into the condensers and, until the cleaning system now in service there was developed, the job was a troublesome one. Rubber plugs, wire brushes, and water and air were tried, in turn, without the desired effect; and while sand-blasting was satisfactory as far as the cleaning went, it also removed considerable of the tube metal. In some cases, a loss in weight of 3 per cent was noted after the tubes had been subjected to the attack of 300 quarts of sand. This action, of course, differs with the amount of sand used, its abrasiveness, and the hardness of the metal.

As a substitute for the sand, pulverized fuel ash was next tried. This, when mixed with a small amount of sand and water, was found to do the work almost as well as sand, alone, and showed little tendency to wear away the metal. One part of sand to three parts of ash, with enough water added to make a thin mix, proved to be the best proportion. With such a mix one condenser tube was subjected to 100 cleaning operations—the loss in weight at the end of the test being negligible.

Special equipment has been provided at the East River Station to apply the cleaning mixture, and this consists mainly of two tanks, each about 3 feet in diameter and 5 feet high, with a hopper set in the top to facilitate loading. Nine buckets of ash, three of sand, and water to fill the tank, constitute a charge. When in use, the contents are kept agitated with compressed air at a pressure of 100 pounds per square inch. The air, like the water, is admitted at the bottom of the tank, whence it is distributed throughout the mass by means of a ring of perforated piping. A flap valve prevents the air from forcing its way into the hopper.

Also at the bottom of the tank are two connections for 1-inch hose carrying nozzles made to fit the condenser tubes. These nozzles, with their quick-acting valves, are held firmly against the tube openings and, for but a few seconds, are permitted to send jets of the scouring mixture through the respective tubes. With both nozzles in operation, a charge is sufficient for half an hour's work; and three men—two at the nozzles and one at the tank— can thus clean a condenser containing about 10,000 tubes in six hours. As a condenser at the East River Station is seldom available for cleaning for more than three hours at a stretch, it can be appreciated that the new equipment is an asset because of the speed and the efficiency with which this phase of the plant operations can now be done.



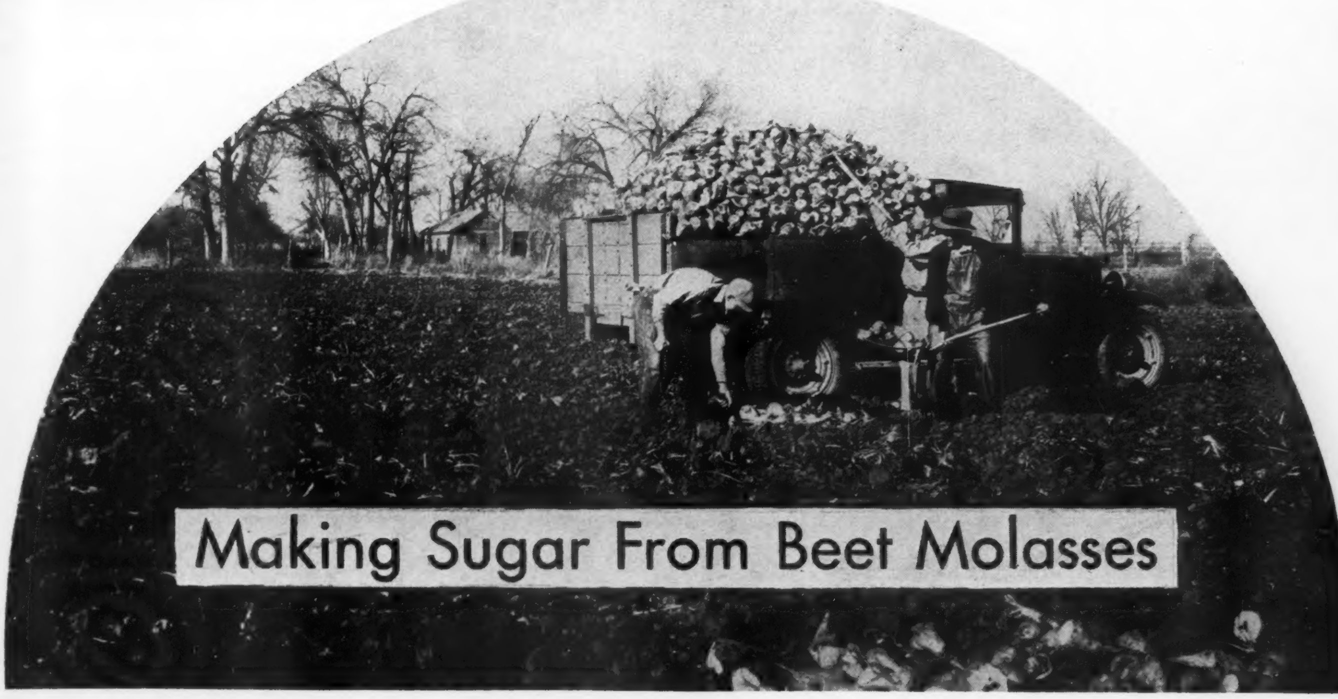
Courtesy, Power

Elevation and plan of the equipment installed at the East River Station of the New York Edison Company to clean condenser tubes.

SUBMARINE SAFETY APPARATUS

SOMETHING new in life-saving equipment designed for use in connection with submarine boats is reported from Spain, where it has recently been undergoing tests in the waters off Cartagena. It consists of a so-called elevator, attached to a buoy, and is said to have successfully brought to the surface from a depth of 150 feet first the inventor and then, in succession, the quartermaster and one of the crew of the submarine *C-3* of the Spanish Navy.

One person is lifted at a time—the elevator and the buoy being lowered and raised repeatedly until all those that can make their escape from a sunken submarine have been rescued. The apparatus is self-contained and can be built to withstand high pressure. While no information on its method of operation is available, the elevator is probably carried downward by the admission of water and made to ascend by the expulsion of that water with compressed air.



Making Sugar From Beet Molasses

By G. Z. MELLEN

IF sugar were sold as a medicine or a reagent it would be marked C.P., meaning chemically pure, because it has a higher actual purity than most other foodstuffs. The reason for this is found in the method of crystallizing sugar from its supersaturated syrups. Non-sugars do not readily enter the composition of the sugar crystals, consequently the syrup retains the impurities and is effectively separated from the sugar in centrifugal machines. When this syrup is boiled a second and a third time to obtain more sugar the impurities become concentrated, and the syrup takes the name molasses. The crystallization and separation of sugar from molasses is difficult and not economically feasible in the ordinary factory.

Steffen houses are operated jointly with some of the beet houses, and there a special treatment eliminates many of the impurities and increases the production of sugar accordingly. Prior to 1925 the final molasses thus obtained was used for feeding livestock and for certain industrial purposes. It contained about 50 per cent sugar, and the price procured was not commensurate with the sugar value.

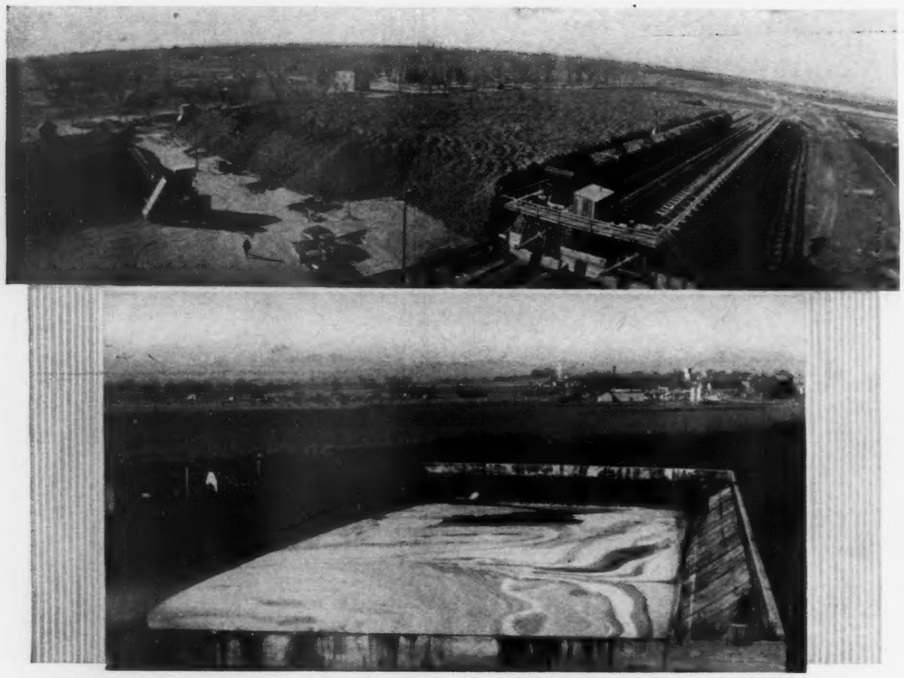
Six years ago The Great Western Sugar Company launched upon a bold venture and a big experiment, applying modern machinery and methods to a technical process untried in many of its aspects and practically unknown to the operating force. Now a smooth-working, efficient plant is running day and night, the year round, manufacturing refined sugar from by-product molasses shipped to it from 21 beet-sugar factories. These factories are owned by The Great Western Sugar Company and are located in Colorado, Nebraska, Wyoming, and Montana.

The molasses plant is centrally located at Johnstown, Colo. It is a unique plant in that it is said to be the only one of its kind in the world—the principles involved having but limited application elsewhere. It is commonly known as a "barium plant" because barium-hydrate is used in the process to precipitate sugar from the molasses. The method of obtaining the barium-hydrate and of regenerating it is an unusual one.

In order to reach a proper understanding of the process and the applications of compressed air it is essential to keep in mind several fundamental facts and features. Witherite is a natural barium carbonate that needs only preparatory grinding before its introduction into the system. The cost of this commodity necessitates economy in its use, and this is achieved by recovery and by regeneration. The theoretical conversion of barium carbonate to hydrate is accomplished by exposing it to high temperature and then leaching it in water; but in practice, owing to its fusible nature, it is diluted with barium-silicate sludge before burning in a kiln. This makes it analogous to Portland cement, but with this difference—the barium cement is partly soluble in water and cannot be utilized for the making of concrete. However, it has many of the characteristics of cement, and is handled accordingly. The success of the whole process is interwoven with the use of compressed air and vacuum; and by showing how these are applied a description of the process follows incidentally.

Starting with barium, slurry—that is, kiln feed—is made up in batches in one of four mixing tanks. Definite proportions of barium-carbonate mud and of barium-silicate sludge are introduced and intimately mixed. This is accomplished by a revolving mechanism with air jets in the bottom of the tank. Compressed air escaping from these jets bubbles up through the slurry, causing its agitation and mixing. Continuous circulation and further mixing is obtained by an independent air lift rising through a central column in the tank and overflowing on to revolving launders. After mixing, the slurry is sent in its proper turn to the kiln through a bottom

Sugar beets in the field, pulled and topped.



Top—Pile of beets at Fort Morgan made up of 43,000 tons of the roots. Bottom—Tank containing molasses from sugar beets.

discharge valve. It is frequently necessary to turn a "shot" of compressed air through this valve and into the tank in order to clear the passage going to the kiln.

On its way to the kiln the slurry passes over Oliver filters so as to remove most of the contained water. This is done by vacuum, which draws the water through a fabric blanket. For this purpose the vacuum is applied to successive sections of a drum, as it rotates. On the submerged part of the drum it acts as a "pick-up", drawing a layer or "cake" of slurry against the fabric. Then, as the drum turns, it serves to hold the cake in position and to dry it further. Later the vacuum is broken and compressed air applied in its stead, causing a "blow-off" of the cake on to a scraper which, in turn, drops it on to a scroll leading direct to the kiln.

The kiln is 160 feet long and is lined with refractory brick. It is inclined slightly from the horizontal and has a slow rotation so that the slurry rolls, first, through a drying zone, next through a warming and heating zone, and then into a fire zone where it is subjected to the direct action of a natural-gas oxidizing flame. There it is raised to a temperature of 2,200° F. and converted into clinker. After passing through a short cooling zone the clinker drops directly on to a chain bucket conveyor which carries it to a ball mill for grinding.

The hot clinker is ground wet, being accompanied into the ball mill by the barium solution—the slacking and the leaching actions aiding materially in the grinding operation. After being classified in a steam-heated Akins classifier, the pulp and the solution overflow into a launder that empties into the first of a series of three Dorr agitator tanks.

Owing to its cementlike nature, the material must be kept hot and continually in motion to prevent solidifying. It not only sets quickly but it is very caustic. The handling of this material in the deep agitators is done by a central air lift working in conjunction with a rotating mechanism having rakes and distributing launders. High-pressure air, low-pressure air, and live steam are all available for the manipulation and control of these air lifts.

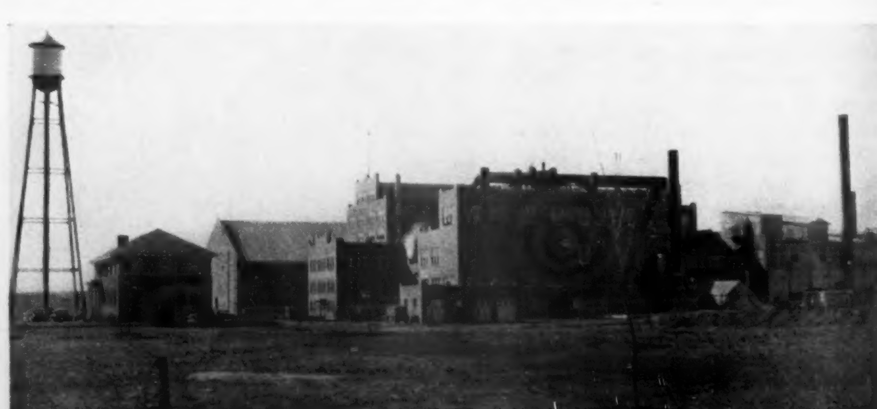
Occasionally a tank is "lost" on account of overload or mechanical difficulty, and it becomes necessary to empty and to clean it by pumping out the solution and by lifting the settled mud in buckets by means of an air hoist. It requires organization and dispatch to raise the 40 or 50 tons of quickly setting mud before the mass hardens into concrete. No time is available for allowing the tank to cool. Instead, cooling ventilation is created by high-velocity air fed through an 8-inch hose from a centrifugal compressor. When the material does harden, despite all efforts, it is broken up with "Jackhamers" working as concrete breakers.

Overflowing from the third agitator, the mud and the solution go into the first of a number of Dorr thickeners operating under a counter-current decantation system. This washes the sludge and allows the strong barium-hydrate solution to overflow. The sludge has a tendency to harden. To offset this, compressed air is used to open up partly closed pipe lines and, at times, to agitate the sludge inside the tanks.

The clear, strong solution obtained by this process is pumped into a series of four crystallizers, where it is cooled by circulation through banks of cold-water tubes—the supersaturated solution thus being made to form barium-hydrate crystals. The crystals and the solution overflow into an Oliver filter, in which the separation and the drying of the crystals are effected by the action of vacuum and by a Monel-metal screen covering the filter drum. In brief, vacuum is used at this stage for both picking up and drying but not for blowing off. The crystals are scraped from the revolving drum and then elevated to the fourth floor of the saccharate building, where they are again put into a solution of standard high strength.

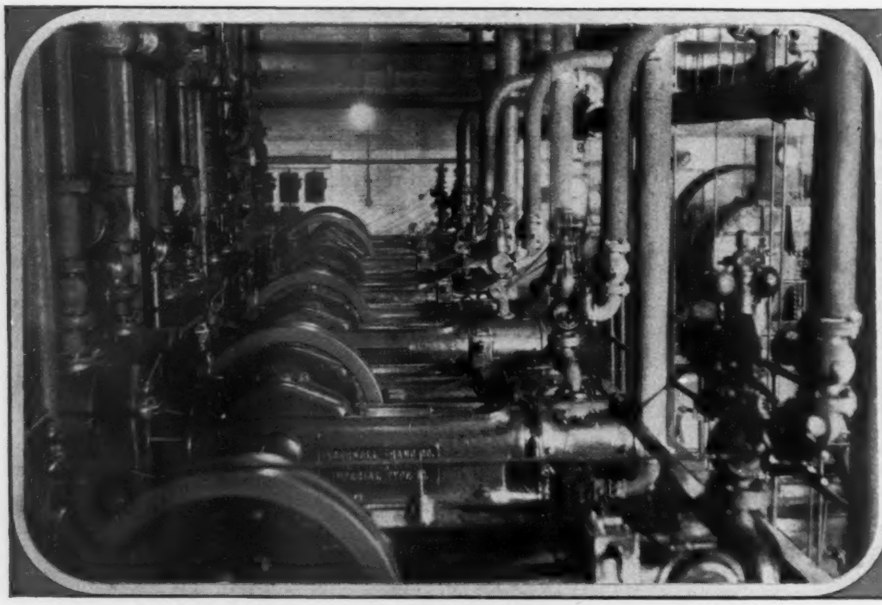
Measuring pumps discharge definite proportions of this solution and of dilute molasses into a series of three Dorr precipitation tanks in which the two ingredients are intimately mixed and combined. This is accomplished by revolving paddle arms working in conjunction with a central air lift, and, further, by intermediate air lifts between the tanks. The creamy saccharate formed in these tanks overflows into a storage tank and thence into the load tank of a Moore filter.

Into the saccharate an electric crane lowers a "basket" of canvas-covered frames, after which vacuum is applied to all the frames simultaneously. This serves to draw the mother liquor through the canvas into a receiver and pipe line. Saccharate cake is formed in this way on each frame. When this is built up sufficiently, the whole load is lifted from the tank by the crane, which also transports it to a wash tank and lowers it into a weak solution of barium hydrate. The vacuum is maintained throughout these operations by means of a flexible-hose connection and holds the cake in position during the movement of the load. By drawing the wash solution through the cake in the tank the vacuum displaces the retained mother liquor and frees the cake of impurities; and not until the crane has carried the load to what is called the unload tank is the vacuum broken and compressed air supplied in its place



The Johnstown plant.

1—Vacuum pans in which syrup is boiled to induce crystallization. The juice heater at extreme right has an air-operated temperature regulator. 2—Presses by which precipitated barium carbonate is separated from the sugar solution. 3—Centrifugal machines that separate the crystallized sugar from the mother syrup and molasses. 4—Quintuple-effect evaporator that operates on exhaust steam and under increasing vacuum. 5—These slurry filters use vacuum and compressed air.



Battery of Imperial Type compressors and vacuum pumps.

to blow off the cake and to discharge it into that tank. Compressed air is also used at the Moore filter station to agitate the wash water and to operate two inaccessible control valves.

In the unload tank the saccharate cake is diluted with sweet water to form a "milk". This is pumped to carbonation towers where compressed boiler flue gas is allowed to percolate upward through the milk until a saturation of CO_2 gas is obtained. This precipitates the barium as carbonate, and liberates the sugar into the solution. The carbonated milk is next pumped into plate and frame filter presses in which the "thin juice" is passed through fabric and discharged as a clear sugar solution. The cake retained in the press is dumped by hand into a storage tank, ready for use in the next slurry mixture. The frames on the filter presses are cleaned periodically by sand-blasting them.

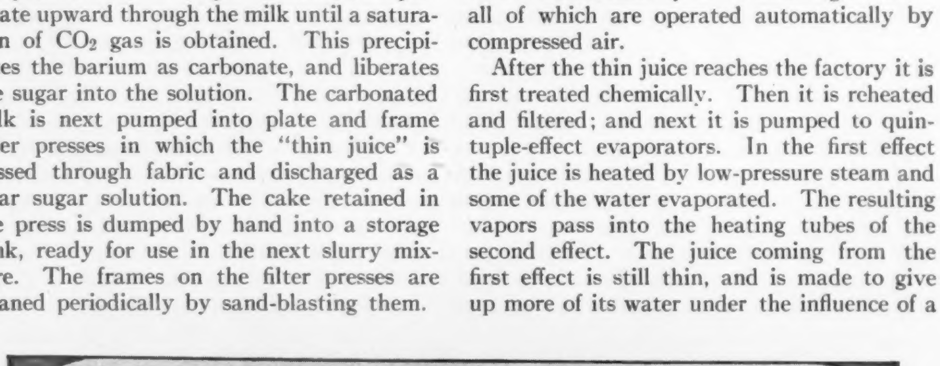
The thin juice is pumped into the sugar end of the factory. On its way it goes through a steam heater that raises its temperature to a predetermined degree by an automatic temperature regulator which is dependent upon compressed air for its functioning. During the subsequent travels of this juice and of its syrup and molasses derivatives the temperature is maintained by 27 of these regulators—all of which are operated automatically by compressed air.

After the thin juice reaches the factory it is first treated chemically. Then it is reheated and filtered; and next it is pumped to quintuple-effect evaporators. In the first effect the juice is heated by low-pressure steam and some of the water evaporated. The resulting vapors pass into the heating tubes of the second effect. The juice coming from the first effect is still thin, and is made to give up more of its water under the influence of a slight vacuum—the vapor so produced going to the third effect, and so on to the fifth effect which operates under 25 inches of vacuum. The thin juice is thus converted into thick juice. Between the fourth and the fifth effects the juice is given a little side trip to "char filters". There it percolates downward through some 20 feet of animal charcoal which removes certain organic impurities.

In the operation of these filters the char loses its "life" after a run of several hours and needs to be revivified by burning in a retort kiln. To do this, the char in the filter is washed with water and then "blown down", which means that the entrance of wash water is stopped and compressed air is admitted in its place. Entering at the top, it follows and displaces the water, which leaves through a filter fabric in the bottom. The air supply is shut off after it has partly dried the char; and then the filter is emptied and refilled with freshly burned material.

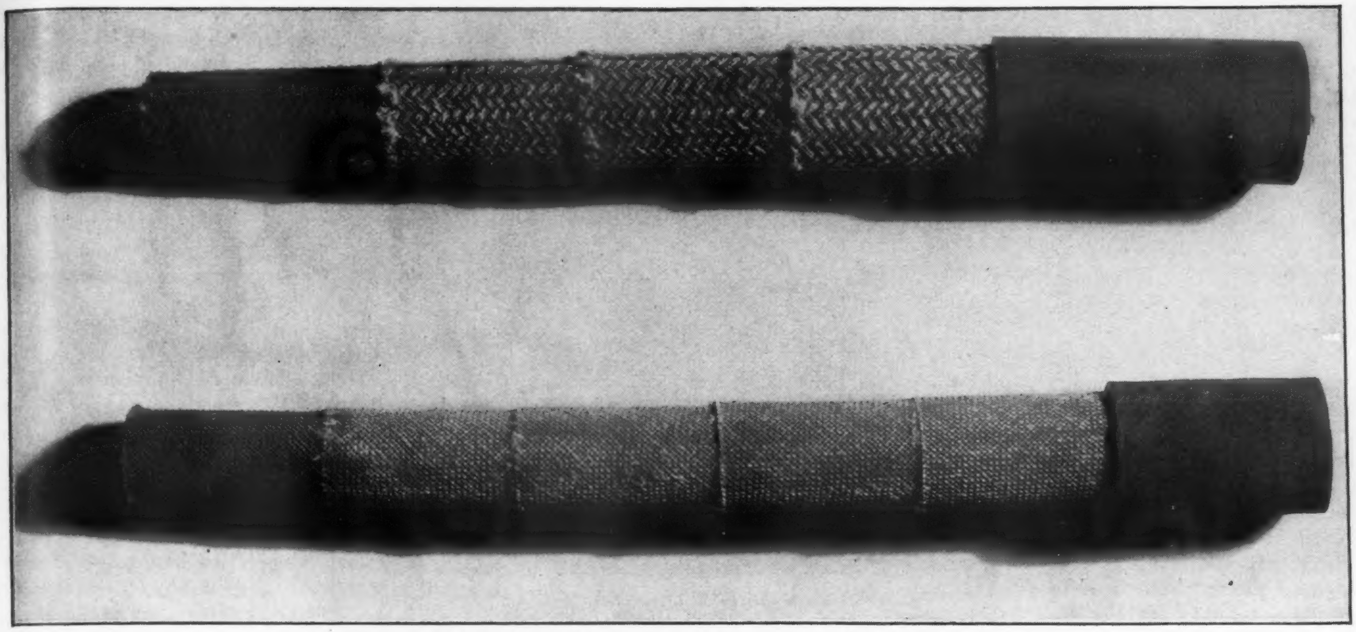
After leaving the fifth effect evaporator the thick juice is "adjusted" by what is termed pH control. It is now ready for boiling into sugar in a pan storage tank. A charge is drawn into a pan, which is a steam-coil, vacuum crystallizer. In this the vacuum serves not only to accelerate evaporation but also to keep the temperature down, thus preventing the sugar from burning or caramelizing. Under the watchful control of the sugar boiler, the charge is evaporated to such a degree of supersaturation as to cause graining of the sugar. That is, a certain relative number of minute sugar crystals are allowed to form. Then a small "drink" is drawn from the pan storage, and the crystals are made to grow without permitting the formation of any new ones. By continuing to take intermittent drinks the crystals are kept growing; and when the pan is full and "brought together" the crystals are of uniform standard size. The mass of sugar and syrup, called massecuite is now dropped into a mixing hopper. This is accomplished by first breaking the vacuum and then quickly opening a large discharge valve.

From the mixing hopper the massecuite is run, in intermittent batches, into centrifugal machines. These spin the syrup through fine-mesh screens, leaving the sugar caked against the perpendicular sides of the machines. After washing with distilled water the machines are stopped and the sugar "cut" or plowed through a central opening into a scroll beneath. It is then dried by warm air as it passes through rotating granulators, from which it is discharged by way of a bucket elevator into "dry bins". This done, the sugar is automatically weighed and sacked and stored in a warehouse ready for orders from candy makers. While awaiting shipment the sugar is protected from fire by a dry-pipe automatic sprinkler system, which depends upon compressed air to hold the water back until released by fire or heat.



Punching a fire-ring, fused clinker, out of a big kiln.

According to a recent survey by the Department of Commerce, a total of $115,068,500 is invested in the 1,113 commercial and municipal airports in use in the United States on January 1, 1931.



Top—Braided type of hose. Bottom—Wrapped type of hose.

Manufacture and Use of Air Hose

Facts About Air Hose and What Should Be Considered in Getting the Best Service from It

By GEORGE K. BEDUR*

HOSE is one vital form of the arterial system that distributes energy in industry. It is undoubtedly true that hose has played an important part in the development and the varied uses of compressed air. Hose has made possible the employment of tools and methods that might not have been conceived had efficient and flexible means for conveying the air been unavailable.

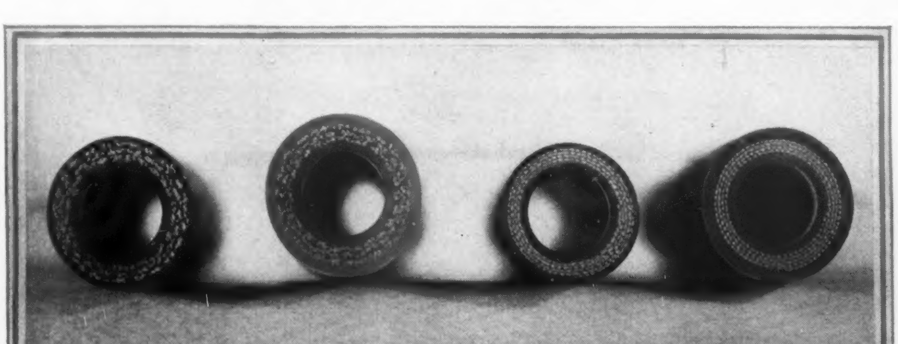
Broadly stated, there are two distinct types of hose in general service today—namely, the wrapped and the braided types. They derive their names from the methods employed in their construction. The wrapped type is made by wrapping a series of rubber-impregnated-fabric plies or layers over a rubber tube which is supported internally by a steel mandrel. These plies are then entirely encased by a rubber cover which keeps moisture out of the fabric carcass and protects it from wear and abrasion. Before vulcanization, several layers of untreated fabric are wrapped, under tension, over this construction. These compress the carcass during vulcanization but are afterwards removed, as is also the mandrel when vulcanization has been completed.

Braided hose is so called because the cotton reinforcement consists of yarn which is braided over a rubber tube. The plies of braided yarn are separated by distinct layers of rubber, and the final ply or braid is covered or insulated by a layer of rubber forming a cover similar to that on hose of wrapped construction. Before it is vulcanized the hose is placed within a lead tube or pipe, and then internal pressure is applied during the process of vulcanization. As a result, the hose becomes a very compact mass of rubber and fabric that will withstand the most severe service conditions. While wrapped hose is limited to 50-foot lengths, braided hose can be made in lengths up to 500 feet. Fifty-foot lengths, however, have generally proved suited to the needs of the majority of users and have, therefore, become practically standard.

Many users of air hose are under the impression that the rubber parts add to the bursting resistance of the hose. An air hose derives its strength to resist rupture from the fabric and from the method by which that fabric is built into the hose. In some constructions the rubber parts do add from 5 to 10 per cent to the strength of the hose to resist bursting, but this characteristic depends upon the size of the hose, the thickness, and the quality and the hardness of the rubber parts. These factors, however, are not given primary consideration in designing hose. In the case of the wrapped kind, the weight of the fabric and the type are the controlling factors. In braided hose, conversely, the size and the strength of the yarns, as well as the angle at which they are applied in relation to one another, are the determining factors.

In wrapped hose the fabric is usually applied on a 45° bias—that is, the warp and the filler threads are placed on an angle of approximately 45° with reference to the axis of the hose. This adds to the flexibility of the product. The fabric, because it is laid up in a series of plies, is virtually a unit in its resistance to bursting pressure, whereas the various plies in a braided construction are individual units. Due to this fact, braided hose requires special skill in its design and manufacture so that the individual units will act together in resisting pressure.

The major portion of hose used in compressor service is probably of the wrapped type. Much has been said for both



Cross sections of both wrapped and braided types of hose with regular as well as with heavy covers.

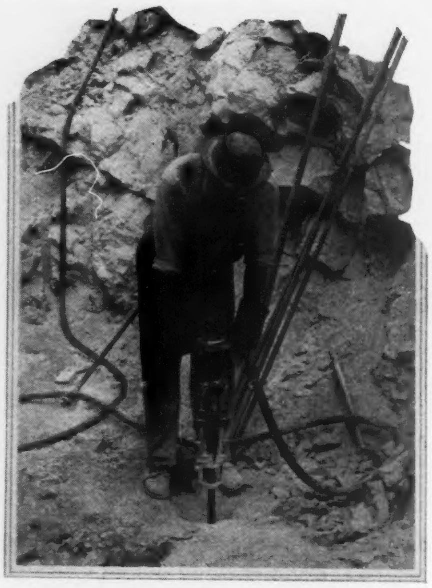
*Production Technical Department, The B. F. Goodrich Company.

types; but it has never been definitely proved which construction has a greater advantage when viewed from the user's standpoint. We might add that wire-winding, in some cases, increases the bursting strength of hose by 50 per cent; but for several years past this construction feature has slowly passed out of the picture because of difficulties which arise in service. The chief of the difficulties is the way in which the air supply may be reduced or be completely shut off when the wire is crushed.

Hose constructed for standard service—that is, from 60 to 125 pounds pressure, with an average demand ranging from 80 to 90 pounds—should have a safety factor of at least 5—that is, the bursting pressure should be five times the working pressure. The better grades of hose in use today usually have still higher factors than this—some going up to 10 and 12. Inside diameter, plies, fabric strength, and principle of construction are the determining characteristics.

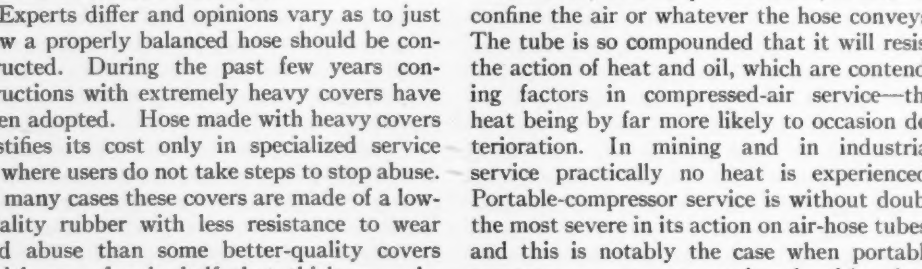
While the question of plies is important, still it should be remembered that a greater number of plies, such as six, seven, or nine, does not always result in a stronger hose, especially in reference to bursting strength. Using more plies of a lighter fabric makes a more compact product than fewer plies of a heavier-weight fabric. This, of course, applies to wrapped hose only, as the same efficiency can be obtained from two to three plies in a braided construction.

Experts differ and opinions vary as to just how a properly balanced hose should be constructed. During the past few years constructions with extremely heavy covers have been adopted. Hose made with heavy covers justifies its cost only in specialized service or where users do not take steps to stop abuse. In many cases these covers are made of a low-quality rubber with less resistance to wear and abuse than some better-quality covers which are of only half that thickness. An extra-heavy cover which outwears the balance of the construction is of no material benefit to the user of hose. Tie-tamping service, for example, wears hose covers severely, but the wear is uniform. The writer has observed hose in this service which was still in excellent shape after three years, although not of the heavy-cover type. This construction has made service records of more than five years.



Air hose coupled to a "Jackhamer".

The tube, as in any other hose, is used to confine the air or whatever the hose conveys. The tube is so compounded that it will resist the action of heat and oil, which are contending factors in compressed-air service—the heat being by far more likely to occasion deterioration. In mining and in industrial service practically no heat is experienced. Portable-compressor service is without doubt the most severe in its action on air-hose tubes; and this is notably the case when portable compressors are not equipped with after-coolers. This phase of our subject is discussed in detail later on.



Two improper methods sometimes used in coupling air hose.

Heat has two distinct and different effects on a tube, depending upon the composition of the tube. One type of tube will dissolve and pass through the hose and the tools. The other type of tube hardens and chars so that it is carried away in small particles which clog the tools and often cause considerable damage. In some cases pistons have to be driven out of tools with sledge hammers. This condition, of course, does not occur when after-coolers are used or when the compressors are in good operating condition.

The utmost skill is exercised by manufacturers of hose in designing and turning out a tube to meet service conditions. Research is carried on continually, and wonderful strides have been made in improving rubber so that it will the better withstand the destructive effects of heat and oil.

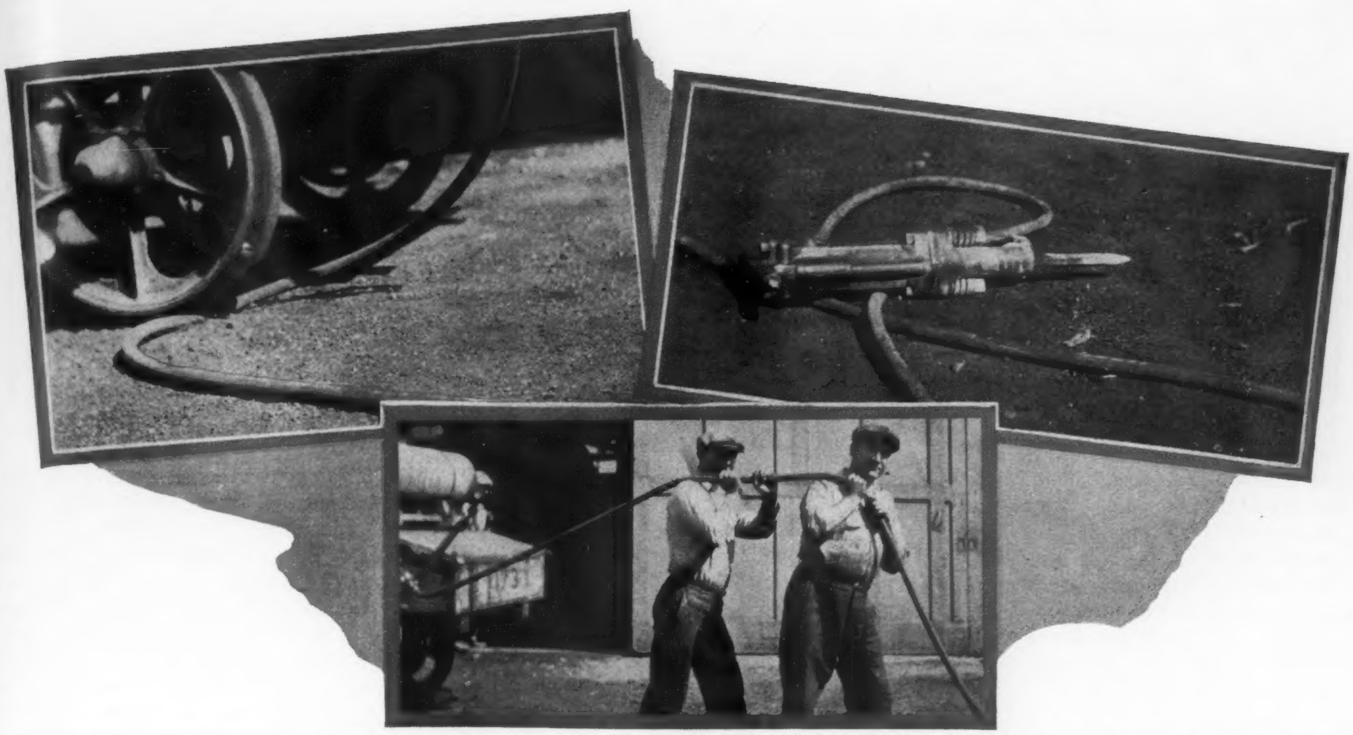
Heat and oil do not affect all kinds of rubber alike. Oil, although it has a damaging effect on rubber, will not cause a good air-hose tube to fail prematurely—that is to say, if the oil be such as is used in ordinary compressor service. A worn compressor—one badly in need of repair—will discharge considerable oil. Operators or owners of such machines, however, usually become discouraged by the frequent demand for replenishing oil, and they see to it that the machines receive the necessary corrective attention. Different types or kinds of oil also have varying effects on rubber. Some of the oils which have the highest lubricating efficiency are, nevertheless, the most severe in their damaging effect upon rubber.

Although the use of line oilers is no cause for rejoicing on the part of hose manufacturers, still this adverse feeling towards oilers has been more or less due to inferior types of oilers put on the market from time to time. The present properly constructed oiler does not cause the hose manufacturer any worry.

Abuse in mine service puts more hose out of commission than do the combined services of portable or stationary compressors. This is attributable to two causes: the first being lack of space in which to properly handle the hose; and the second is the consequence of modern methods and production costs which do not permit operators to take either exceptional or, in some instances, even ordinary care of hose. This state of affairs is fairly prevalent in American mines. In other countries, however, operators are characteristically more careful about equipment.

In some mines the workmen do not even remove the hose from the immediate vicinity of a heading preliminary to blasting. The result is obvious, especially if the charge be a heavy one or the material be sharp and bulky. Some mines operate on one-fifth as much hose as do others. It all depends upon the attitude of the mine management. This is a condition over which hose manufacturers or dealers have no control.

Hose in mine service is generally heavier than that used in industrial or portable-compressor service, although there are many mines that claim excellent results from hose of standard construction. Subway work, rock tunneling and grading, and quarrying can be properly classed as mine service.



Some of the abuses to which hose is subjected. Left—Much hose is injured by the wheels of vehicles. Right—Both fabric and tube are often damaged by dropping heavy tools on hose. Bottom—Pulling a compressor by means of attached hose.

What may be described as stationary and industrial service comprises general shop use, repair work, and industrial plants of one sort or another. As in mine service, the air commonly reaches the hose through pipe lines; and in some cases the air carries in suspension small quantities of oil that do not affect the hose adversely. The service is comparatively easy on air hose; and, with ordinary care, a hose of light construction will perform well for years. In fact many users demand very light hose, although it has been demonstrated that a standard hose earns its increased cost.

Portable-compressor service has shown exceptional increase in recent years, and probably exceeds all other kinds of air-compressor service. It is estimated that there are many thousands of portable compressors in use today; and each of these is utilizing from 100 to 300 feet of hose. In the case of tie tampers, as much as 800 feet is often needed with a single compressor unit.

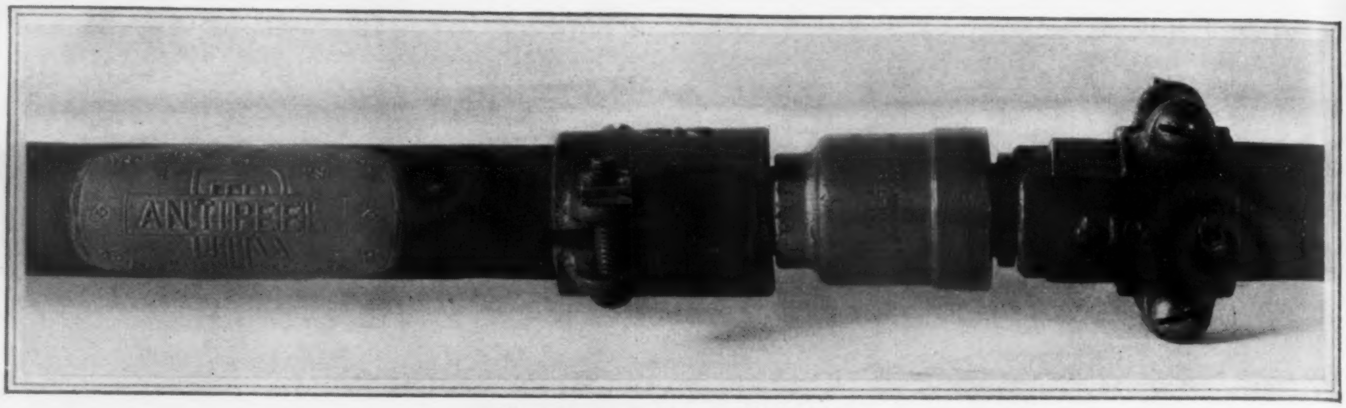
As portable compressors have increased in number and more ways have been found to adapt them advantageously their operation and upkeep in many instances have shifted from the hands of skilled mechanics to those of ordinary laborers. This situation, combined with the fact that the compressors must operate out of doors and under all kinds of weather and climatic conditions, has made it extremely difficult to establish exceptional records in the use of hose. The service is the hardest and the most difficult with which hose has to cope. Practically each portable has its own peculiarities, and these reflect themselves more or less directly in the performance of the hose.

On paving jobs, or where the operating space is limited, much hose is ruined by abuse. It is often run over by trucks. Tools, ties, or rails are allowed to fall on it; and innumerable things can happen which will cause hose to fail. Similar abuses occur in excavation and construction work, with the exception of tie tamping in which very little abuse of hose takes place.

While the cost of producing compressed air varies with the type of compressor used, still the cost in any event is considerable. Much of the air is wasted because of improper coupling of hose; and this is often due to the fact that operators are not disposed to spend the money needed for suitable couplings. Furthermore, some of the methods employed in coupling hose cause the couplings to blow out, thereby endangering the workmen.

One wrong method most commonly found is the use of pipe nipples or ordinary shank couplings that are held in place with standard

Left—Improper way of coupling hose to an air receiver. Right—The proper way of coupling a hose to a receiver or a manifold.



The proper way to couple air hose.

bands or clamps. Couplings which give the best results and occasion the fewest accidents are of the so-called high-pressure type. These have clamps which fasten on to the coupling shank as well as to the hose. Another good coupling is one which has an enlarged flange on the shank. This makes it impossible for the coupling to pull out of the hose. The most satisfactory coupling is the quick-detachable type. It has no threads or gaskets to loosen or to become detached; and it is exceptionally well adapted to portable-compressor and light pneumatic-tool service.

SILICA FOR WEATHERPROOFING

SILICA, we are told by those qualified to speak, is the most abundant constituent of the earth's crust, and one of Nature's most permanent compounds. The mineral has varied applications—in the making of glass, pottery, etc., but others have latterly been added to the list that are of especial interest because they have come about primarily by reason of silica's inherent property to endure.

English researchers, so it seems, have developed and put to practical use silicon compounds in the form of esters that serve to give permanence to disintegrating stone surfaces and to increase the service life of paints. Westminster Abbey is supposed to have been treated with the new preservative to prevent weathering. When suitably applied, the ethyl silicate will penetrate deeply into the interior of crumbling stone, marble, plaster, and other similar materials, where it turns into a colorless jelly. This jelly becomes very hard when dry, binding the particles in an insoluble mass.

The other form of ethyl silicate that is used as a binder in paint has the advantage of making the paint insoluble in a few hours after it has been applied. In consequence, it is possible to put on a second coat of a different color in an hour without fear of the colors running. Although rapid, the process of setting continues progressively for about four months, so that the finished work, whether inside or outside, is very hard. The pigmented ethyl silicate may be used in combination with the preservative silicate to paint as well as to prevent the weathering of stone, wood, iron, brick, plaster, etc. The products are still too costly for any but exceptional service, and are not yet obtainable in the United States.

OIL-ELECTRIC LOCOMOTIVES MAKE FINE SHOWING

TWO occurrences within the past few weeks have given added emphasis to the practical and the potential value of the oil-electric locomotive. The first of these was a contract awarded by the Bush Terminal Company to the Ingersoll-Rand Company for seven 55-ton oil-electric locomotives for switching service at its great Brooklyn terminal. The power plant of each unit will consist of an Ingersoll-Rand 300-hp. Diesel engine developed especially for railroad use.

The determination on the part of the Bush Terminal Company to adopt oil-electric locomotives matured only after that company had made an exhaustive investigation and had ascertained by actual demonstration in the Brooklyn plant just what the oil-electric locomotive could be confidently counted upon to do. This is one more evidence of the alertness of the terminal company and of its unfailing efforts to keep the whole establishment up to date in all its interconnected operating departments.

The second significant occurrence was a demonstration at Erie, Pa., on April 1, of an 800-b.hp. oil-electric locomotive built by the Ingersoll-Rand Company on order from the Erie Railroad. The performances of this locomotive were witnessed by 70 visitors, among them representatives of nineteen trunk-line railroads and of a number of large industrial concerns. The locomotive was run over a 5-mile stretch of test track having a 1 per cent grade, and was required to make three runs with trailing trains of 500 tons, 1,000 tons, and 1,500 tons, respectively. On the third run, with the heaviest of the trains, the train was stopped on a .9 per cent grade and started on the grade from that point. Notwithstanding the fact that snow was falling, and the tracks were wet and slippery, still the locomotive started easily and accelerated rapidly—showing conclusively the tractive capacity of the oil-electric type of locomotive.

The performances were highly successful and provoked much favorable comment from the experts present. There were two other Ingersoll-Rand oil-electric locomotives on exhibition at the same time—one of 300-b.hp. and another of 600-b.hp. The electrical equipment for the locomotives was furnished by the General Electric Company.

The primary source of power of the 800-b. hp. oil-electric locomotive built for service on the Erie Railroad.

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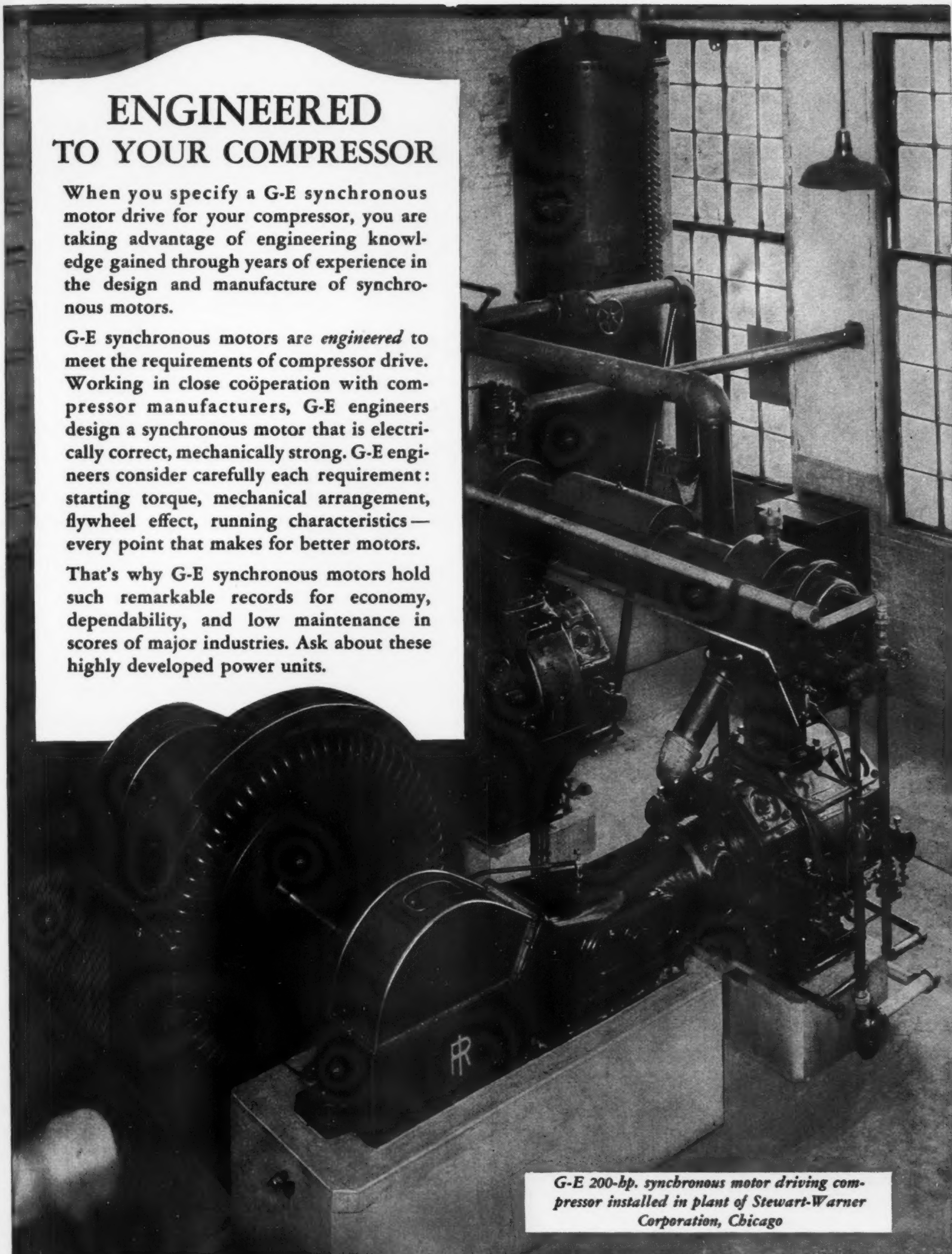

G-E 200-hp. synchronous motor driving compressor installed in plant of Stewart-Warner Corporation, Chicago

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GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

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